(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : 0 611 638 A1

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number : 94301140.3

(22) Date of filing : 17.02.94

(51) Int. Cl.[5] : B27N 3/24, B27N 3/20, B27N 3/08

(30) Priority : 18.02.93 JP 28956/93
18.02.93 JP 28957/93
18.02.93 JP 28958/93
05.07.93 JP 165723/93
05.08.93 JP 194870/93
11.08.93 JP 199638/93
14.09.93 JP 228764/93
14.01.94 JP 2803/94

(43) Date of publication of application :
24.08.94 Bulletin 94/34

(84) Designated Contracting States :
AT DE DK FR GB IT SE

(71) Applicant : EIDAI CO. LTD.
10-60, 2-chome Hirabayashiminami
Suminoe-ku, Osaka (JP)

(72) Inventor : Nishio, Jiro, c/o EIDAI CO LTD
10-60, 2-Chome, Hirabayashiminami
Suminoe-ku, Osaka-shi, Osaka (JP)
Inventor : Fujii, Yoshinobu, c/o EIDAI CO LTD
10-60, 2-Chome, Hirabayashiminami
Suminoe-ku, Osaka-shi, Osaka (JP)
Inventor : Kadokawa, Noriko, c/o EIDAI CO LTD
10-60, 2-Chome, Hirabayashiminami
Suminoe-ku, Osaka-shi, Osaka (JP)

(74) Representative : Senior, Alan Murray et al
J.A. KEMP & CO.,
14 South Square,
Gray's Inn
London WC1R 5LX (GB)

(54) **Process for stabilizing lignocellulosic material and device therefor.**

(57) A process capable of improving dimensional stability and surface properties of a lignocellulosic material is disclosed which comprises holding a lignocellulosic material (W) between hot platens (1a,1b) in a sealed condition, and heating the lignocellulosic material to vaporize moisture contained in the lignocellulosic material per se ; thereby effecting high-pressure steam (V) treatment of the lignocellulosic material. In the treatment, the lignocellulosic material may be maintained in a compressed condition, or an external high-pressure steam (V) may be supplied from the surfaces of the hot platens toward the lignocellulosic material.

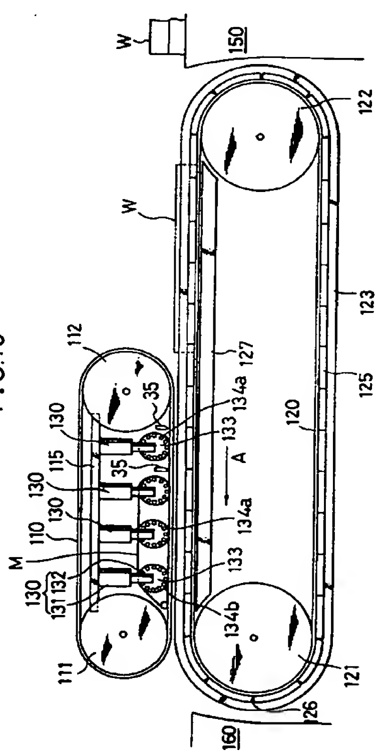


FIG.10

Jouve, 18, rue Saint-Denis, 75001 PARIS

The present invention relates to a process for stabilizing a lignocellulosic material and a device therefor. In particular, it relates to a process for stabilizing a lignocellulosic material which is capable of improving dimensional stability or surface properties of a lignocellulosic material to obtain a lignocellulosic material suitable for use in construction or furniture production, and a device therefor.

In recent years, hardwoods of good quality have been on the decrease and sufficient supply of hardwoods has not been attained, and accordingly attention has been given to coniferous woods, medium duty fiber-boards (MDFs), particle boards and the like as alternative materials to hardwoods.

However, coniferous woods are generally softer than hardwood and have problems in surface properties such as surface hardness and resistance to surface abrasion, resistance to moisture and resistance to heat, mechanical strength and the like when used as materials for construction or furniture. On the other hand, swelling in the thickness direction is a large problem to MDFs and particle boards.

Accordingly, with respect to coniferous woods, a technique is known which comprises boiling or steaming a coniferous wood to effect softening, and then hot-pressing the resulting coniferous wood by means of a compression machine with flat platens to compress and densify (hereinafter referred to as compaction) to a thickness of about 20 to 70% of the original thickness (Japanese Patent Laid-open Publication No.126202/1992). When a coniferous wood is compacted, remarkable effects are obtained in the above-mentioned surface properties, resistances, mechanical strength and the like. Upon exposure to moisture and/or heat, however, force urging the compacted coniferous wood to return to its original state is caused by the action of moisture and/or heat, and as a result, the coniferous wood which has been copmacted on purpose to improve performance is adversely restored substantially to the original state.

In order to prevent the above-mentioned restitution of a compacted coniferous wood and the swelling in the thickness direction of MDF or a particle board, it has been attempted to apply chemical treatment such as acetylation or formallation to a lignocellulosic material ("Mokuzai Kogaku Jiten" published on May 20, 1982 by Kogyo Shuppan K.K., pp.6 and 595). However, this method has drawbacks that use of a large amount of chemicals is undesired from an environmental viewpoint, that it is difficult to effect uniform treatment throughout a whole lignocellulosic material, and that complicated steps result in a high cost. Further, with respect to compacted coniferous woods, it has been attempted to impregnate a coniferous wood with a phenolic resin, a polyester resin or the like to effect conversion into a WPC (wood-plastic composite) (above-mentioned reference, page 638). However, this method also has drawbacks as in the above-mentioned chemical treatment that it is difficult to uniformly treat a whole lignocellulosic material, and that complicated steps result in a high cost, and further has a drawback that excellent properties inherent in lignocellulosic materials such as heat insulating properties and air permeability are substantially impaired.

Further, another method has been proposed which comprises treating a compacted lignocellulosic material in an autoclave with a high-pressure steam at 160 to 200 °C for several minutes to thereby prevent restitution of the compacted coniferous wood (Japanese Patent Laid-open Publication No.126202/1992). In this method, however, penetration of the high-pressure steam to the interior (in particular, the center portion) of the lignocellulosic material is tardy, and consequently the treatment is likely not to be uniformly effected, i.e., the degree of the treatment is likely to be different between in the center portion and in the peripheral potion.

The present inventors have made intensive and extensive studies with a view to overcoming the disadvantages involved in the conventional methods for treating a lignocellulosic material. As a result, they have contrived a novel method for treating a lignocellulosic material which is not only capable of preventing a compacted lignocellulosic material from being caused to restore to its original thickness by water and/or heat, but also capable of treating a lignocellulosic material uniformly and efficiently throughout the whole lignocellulosic material, and on the basis of the contrivance, they have already filed a patent application (Japanese Patent Application No.269225/1992).

This stabilizing method comprises subjecting a compression-shaped lignocellulosic material to high frequency electric heating to turn moisture contained in the lignocellulosic material into high-pressure steam while restraining the lignocellulosic material from being deformed, thereby enabling a compacted lignocellulosic material suitable for construction or furniture, which is improved in surface properties such as surface hardness and resistance to surface abrasion and lowered in dilatation due to moisture and/or heat, to be obtained.

The above-mentioned stabilizing method is practically effective. However, since a step for treating a lignocellulosic material in a pressure vessel is required, the procedure is complicated and a device per se is inevitably of a large scale. The present inventors have further continued the studies on a method for stabilizing, and consequently, they have found that a lignocellulosic material, which has dilatation depressed to substantially the same degree as in the case where conventional treatment in a pressure vessel is conducted, i.e., improved dimensional stability as well as improved surface properties, can be obtained by utilizing customary platens used for compressing a lumber or preparation of a composite, without treatment of a lignocellulosic material in a pressure vessel. The present invention has been completed on the basis of the finding.

It is, therefore, an object of the present invention to provide a novel process for stabilizing a lignocellulosic material by the use of a simple device in a simple manner to obtain a lignocellulosic material which is greatly improved in dimensional stability and surface properties and hence which can adequately be used for construction or furniture.

It is another object of the present invention to provide a novel process for stabilizing a lignocellulosic material whose procedure per se is simplified and which enables high productivity to be realized.

It is still another object of the present invention to provide a treating process which enables stabilizing treatment of a lignocellulosic material to be carried out without using a cumbersome sealing means.

It is a further object of the present invention to provide a process for stabilizing a lignocellulosic material which enables a treated lignocellulosic material free from influence of surface properties of hot platens to be obtained.

It is a still further object of the present invention to provide a process for stabilizing a lignocellulosic material which is capable of preventing the surface of a lignocellulosic material from being stained with substance oozing from inside of the lignocellulosic material during treatment of the lignocellulosic material with high-pressure steam.

It is an even further object of the present invention to provide a process for stabilizing a lignocellulosic material which is capable of attain shortened production cycle by continuous treatment and hence which enables further improved productivity to be realized.

It is yet another object of the present invention to provide a device for treating a lignocellulosic material which is adapted to carry out the above-mentioned process.

To solve the above-mentioned problems and to attain the objects, the present invention discloses a process for stabilizing a lignocellulosic material which, generally, comprises:

holding a lignocellulosic material between hot platens in a sealed condition, and

heating the lignocellulosic material to vaporize moisture contained in the lignocellulosic material per se; thereby effecting high-pressure steam treatment of the lignocellulosic material.

A chemical agent for chemical treatment such as acetylation or formalization and/or a chemical agent for plasticization such as ammonia gas, a low molecular weight phenol or the like may be supplied toward the lignocellulosic material simultaneously in order to pursue the above mentioned process.

In the present invention, the lignocellulosic materials include processed materials such as an MDF and a particle board as well as unprocessed materials,. and the above objects can be attained equally with any of these materials. In this connection, the present invention exhibits particular effect when applied to a coniferous wood which is generally regarded as being soft as an unprocessed material, however, the present invention is applicable to a hardwood as well.

The hot platen may be a flat platen used in a customary clamping device used for clamping a lumber or preparation of a composite. In application, the treatment may be conducted with a mirror plate interposed between the hot platen and the lignocellulosic material (when the expression "between the hot platens" is used herein, it includes cases of a hot platen with a mirror-like plate interposed, as above.)

As means for the heating, there may be employed heating by hot platens, and high-frequency electric heatings such as microwave heating (hereinafter referred to generically as "high-frequency electric heating"). In the latter case, a known microwave generator or high frequency generator is disposed in the vicinity of the lignocellulosic material. Alternatively, the heating may be conducted by hot platens in combination with high-frequency electric heating.

Besides, the present invention discloses, as a device preferably used for continuously carrying out the above-mentioned process for stabilizing a lignocellulosic material, a device for stabilizing a lignocellulosic material comprising:

a pair of endless belts adapted to have at least in part a opposed zone and to be such that the opposed surfaces travel in the same direction,

a means for feeding a lignocellulosic material to said endless belts, and

a means for heating the lignocellulosic material fed, said means being located in said opposed zone between the pair of endless belts.

The above-mentioned device may further comprise a means for preliminarily compressing and preliminarily heating the lignocellulosic material fed, said means being upstream relative to said opposed zone between the pair of the endless belts. In addition, it may further comprise a steam supplying means for supplying a high-pressure steam toward the lignocellulosic material in said opposed zone between the pair of endless belts.

Fig.1 is a perspective view primarily showing frames for sealing which can be used for carrying out the present invention;

Fig.2 is an illustrative scheme of stabilizing treatment of a lignocellulosic material using the frames;

Fig.3 is a perspective view showing a rigid v ssel which can be used for carrying out the present invention;
Fig.4 is an illustrative view of stabilizing treatment of a lignocellulosic material using the rigid vessel;
Fig.5 is an illustrative view of stabilizing treatment of a lignocellulosic material using a sheet member and a rigid vessel;
Fig.6 is an illustrative view of stabilizing treatment of a lignocellulosic material using sheet members, a resilient sealing means, and a thickness regulating jig;
Fig.7 is an illustrative view of stabilizing treatment of a lignocellulosic material using sheet members, frames of sealing, and a thickness regulating jig;
Fig.8 is an illustrative view of stabilizing treatment of a lignocellulosic material using sheet members and a thickness regulating jig;
Fig.9 is a perspective view of a thickness regulating jig;
Fig.10 is a diagrammatic view showing one form of a device for stabilizing treatment of a belting press type which is preferably used for carrying out the treatment for stabilizing a lignocellulosic material in a continuous mode;
Fig.11 is an illustration showing a lignocellulosic material under compaction;
Fig.12 is a partial perspective view showing one form of a lower endless belt;
Fig.13 is a diagrammatic view showing another form of the device for stabilizing treatment of a belting press type; and
Fig.14 is a perspective view showing a substrate carrying a lignocellulosic material.

Now, the process for stabilizing a lignocellulosic material and the device therefor according to the present invention will be described more in detail with reference to preferred embodiments.

According to the first embodiment as one of the preferred embodiments, there is provided a process for stabilizing a lignocellulosic material which comprises:

holding a lignocellulosic material between hot platens in a sealed condition, and

heating the lignocellulosic material to vaporize moisture contained in the lignocellulosic material per se; thereby effecting high-pressure steam treatment of the lignocellulosic material,

wherein a lignocellulosic material is held between the hot platens with a sealing means and (a) thickness regulating jig(s) arranged around the lignocellulosic material, and under the condition, the lignocellulosic material is heated.

A chemical agent for chemical treatment such as acetylation or formalization and/or a chemical agent for plasticization such as ammonia gas, a low molecular weight phenol or the like may be supplied simultaneously from the surfaces of the hot platens toward the lignocellulosic material.

For conducting the stabilizing treatment, a lignocellulosic material sized into a predetermined thickness and predetermined dimensions is first placed between hot platens. Then, all around the lignocellulosic material is disposed a resilient sealing means somewhat higher than the thickness of the lignocellulosic material as a final product, and outside the sealing means (is) are disposed (a) thickness regulating jigs having a height equal to the thickness of the lignocellulosic material as an intended final product. As a material for the resilient sealing means, any materials may be used so long as they have sealing function capable of preventing the steam evolved from inside of the lignocellulosic material by the heating of the lignocellulosic material from leaking out, and they have heat resistance and compressive properties as well. However, a resilient packing made of a silicone is particularly preferred. As a material of the thickness regulating jig, any materials may be used so long as they have requisite rigidity and heat resistance. Of these, aluminum metals and stainless steels are preferred, and stainless steels are particularly preferred. Incidentally, the thickness regulating jig(s) is (are) disposed in order to restrict the distance between hot platens with a view to regulating the thickness of the lignocellulosic material resulting from the heat treatment. Accordingly, as opposed to the sealing means, (a) thickness regulating jig(s) disposed along at least opposite two sides of the lignocellulosic material meet(s) the purpose.

After the sealing means and the thickness regulating jig are arranged around the lignocellulosic material, the hot platens are brought close to each other until the hot platen abuts upon the surface of the lignocellulosic material, and at this position, first heating is conducted by means of hot platens. It is desired to conduct the heating at a temperature capable of causing moisture in the lignocellulosic material to be vaporized. By this heating, the lignocellulosic material is softened to some extent. Subsequently to this position, the hot platens are further brought close until the movement is restricted by the thickness regulating jig(s). The lignocellulosic material is thereby compacted and brought into a hermetically sealed condition by the sealing means disposed all around the lignocellulosic material.

In this condition, second heating is sequentially conducted. It is necessary to conduct this heating at an adequately high temperature for causing moisture contained in the lignocellulosic material to be vaporized. The heating temperature may be changed stepwise. For example, the heating temperature is initially caused to

stand at about 200 °C, and then, gradually lowered with time or stepwise brought to a lower temperature after lapse of a predetermined time, thereby enabling discoloration of the surface of the lignocellulosic material due to the heat to be minimized.

In stead of heating by hot platens, high-frequency electric heating may be employed. In this case, since moisture in a lignocellulosic material is uniformly vaporized, more uniform heat treatment can be effected. Besides, heating by hot platens and high-frequency electric heating may be employed concurrently. In this case, more shortened treatment cycle can be realized.

A lignocellulosic material having an initial thickness which is substantially the same as the thickness of an intended final product may be placed on a platen. In this case, the lignocellulosic material is subjected no substantial compaction treatment, and platens are directly brought close until the movement is restricted by (a) thickness regulating jig(s). In this position, heating is conducted by means of platens and/or high-frequency wave.

In the case of a lignocellulosic material, such as a coniferous wood, which is required to be subjected to compaction treatment for densification and improved surface properties, it is preferred to employ a lignocellulosic material having a thickness larger than that of a final product. On the other hand, in the case of a lignocellulosic material, such as a particle board, which requires no substantial compaction, a lignocellulosic material of substantially the same thickness as a final product may be employed and subjected to the heat treatment without compaction.

Further, in the case of a material which is prepared by reprocessing an intermediate material, such as an MDF or a particle board, the treatment according to the present invention may be effected during the step for forming into a lignocellulosic material, or may be effected as post-treatment on a material which has already been formed as a lignocellulosic material (Accordingly, herein, a material referred to as "lignocellulosic material" includes intermediates used in such a step for forming.)

After completion of the predetermined heating, pressure is released. The pressure release may be conducted gradually over a predetermined period of time, or may be conducted in a so-called cold condition by supplying cooling water to the hot platens. When the pressure release is conducted in a cold condition, dimensional change of the resulting final product is small as compared with that in the cases of other pressure release methods, and good surface appearance is attained.

According to the second embodiment of the present invention, a lignocellulosic material is held between the hot platens with a sealing means and (a) thickness regulating jig(s) arranged around the lignocellulosic material, and the lignocellulosic material is heated while supplying high-pressure steam from the surfaces of the platens to expose the lignocellulosic material to the steam. In this connection, a chemical agent may be supplied to gether with the high-pressure steam. In this case, since the chemical agent can be applied to the lignocellulosic material uniformly, disadvantages inherent in the conventional chemical treatments can be overcome at the same time.

In this embodiment, after the sealing means and (a) thickness regulating jig(s) are arranged around the lignocellulosic material, the hot platens are finally brought close until the movement is restricted by the regulating jig(s). In this position, in parallel with the heating by means of the hot platens, high-pressure steam is injected from the surfaces of the hot platens toward the lignocellulosic material in a predetermined amount (for a predetermined period of time). The injection may be conducted stepwise by changing injection conditions (time, temperature, pressure, amount and the like). Upon the injection, the steam supplied from the surfaces of the platens penetrates from the upper surface and lower surface, and also from all side surfaces when a space is provided between the lignocellulosic material and the sealing means disposed all around the lignocellulosic material, into the lignocellulosic material and even into the core portion thereof, thereby enabling intended treatment to be advanced.

With respect to the above-mentioned treating conditions, optimum values are experimentally determined according to the kinds and dimensions of lignocellulosic materials to be treated, and the like. As regards most coniferous woods, it is preferred to maintain, during the injection of the high-pressure steam, the temperature of the platen at 150 to 250 °C, the pressure of the high-pressure steam at a level of several kgf/cm^2 to 30 kgf/cm^2, and the temperature of the high-pressure steam at about 150 °C to about 230 °C. When the supply of the high-pressure steam is stepwise conducted in the first and second steps as described below, pressure of the high-pressure steam is preferably maintained at a level of about 5 kgf/cm^2 to about 7kgf/cm^2 in the first step and at a level of about 10 kgf/cm^2 to about 30 kgf/cm^2 in the second step. The injection time of the high-pressure steam is preferably about 1 to about 10 min.

In the supply of the high-pressure steam, a chemical agent for chemical treatment such as acetylation or formalization and/or a chemical agent for plasticization such as ammonia gas, a low molecular weight phenol or the like may be supplied simultaneously. These chemical agents penetrate uniformly throughout the whole lignocellulosic material together with the high-pressure steam.

The initial thickness of the lignocellulosic material disposed on the hot platen may be substantially the same as the thickness of an intended final product, or may be up to about 300% of the same. In the former case, no substantial compaction treatment is effected, and in the latter case, predetermined compaction treatment is effected. Further in the latter case, the treatment may be conducted in such a manner that first step of the high-pressure steam supply is conducted in a condition where the hot platen is moved until the hot platen abuts upon the surface of the lignocellulosic material, and with the lignocellulosic material thereby soften, the hot platen is further moved until the movement is restricted by the thickness regulating jig(s), and then second step of the high-pressure steam is conducted.

Also in this embodiment, after completion of the predetermined supply of high-pressure steam, the pressure release is conducted in the same manner as above.

According to the third embodiment of the present invention, there are arranged between platens a lignocellulosic material, frames which are each located on each of the lignocellulosic material surfaces each facing a platen and which are each adapted to compress a peripheral portion of the lignocellulosic material, and (a) thickness regulating jig(s) located around the lignocellulosic material for restricting movement of the platen, and the platen is moved to cause the frames to compress the peripheral portions of the lignocellulosic material, and in this condition, the lignocellulosic material is heated.

Also in this embodiment, the heating is conducted by hot platens and/or high-frequency electric heating including microwave heating. As the lignocellulosic material, one having a thickness larger than the height of the above-mentioned thickness regulating jig may be used. In this case, a lignocellulosic material can be obtained which is compressed throughout the whole body with the peripheral portion compressed to a degree higher than the compression degree of the other portion.

The method for stabilizing a lignocellulosic material according to this embodiment will be described more in detail with reference to Figs.1 and 2. In this embodiment, frames are provided which are located on the surfaces of the lignocellulosic material facing platens and which are adapted to compress peripheral portions. Each of the frames 10,10 has substantially the same shape as that of the peripheral portion of the lignocellulosic material W to be treated, and the thickness h and the width w are selected taking permeability and compression properties of the lignocellulosic material and the like into consideration. As a material for the frame 10, any materials may be used so long as they have appropriate rigidity and heat resistance. Of these, aluminum and stainless steels are preferred, and stainless steels are particularly preferred.

Further, (a) thickness regulating jig(s) 3 (see Fig.2) is (are) provided which has (have) a height equal to the thickness of the lignocellulosic material as an intended final product. As a material for the thickness regulating jig 3, like the material for the frame, any materials may be used so long as they have requisite rigidity and heat resistance. Of these, aluminum and stainless steels are preferred, and stainless steels are particularly preferred.

In one mode for carrying out this embodiment, a frame 10 is first disposed on a lower hot platen 1a of a compression device at the beginning of treatment, as shown in Fig.2A. A lignocellulosic material W to be treated is placed thereon with its periphery conformed with that of the frame, and another frame 10 is further placed on the lignocellulosic material W with its periphery conformed with that of the lignocellulosic material. Then, (a) thickness regulating jig(s) 3 which has (have) a height equal to the thickness of the lignocellulosic material W as and intended final product is (are) disposed around or on both sides of the lignocellulosic material W. Hot platens 1a and 1b are brought close until the hot platens abut upon the frames 10, and at this position, high-pressure steam v is injected from the surfaces of the hot platens to cause the lignocellulosic material to absorb the steam v. The lignocellulosic material is thereby softened, and then the hot platens are gradually brought close until the movement is restricted by the above-mentioned thickness regulating jig(s) to compress the lignocellulosic material. The condition is shown in Fig.2B.

In the above explanation, the initial thickness of the lignocellulosic material W is supposed to be larger than the thickness of the thickness regulating jig 3. Therefore, in the condition shown in Fig.2B, the lignocellulosic material W as a whole is subjected to compaction corresponding to the difference between the initial thickness of the lignocellulosic material W and the thickness of the thickness regulating jig 3, and at the same time, the peripheral portion of the is further subjected to compaction corresponding to the thicknesses of the frames 10 in the direction of the thickness. Accordingly, the peripheral portion has a density higher than that of the other portion, i.e., the peripheral portion has higher airtight properties.

In the condition shown in Fig.2B, high-pressure steam v is further injected from the surfaces of the hot platens 1a,1b against the lignocellulosic material. Since the peripheral portion has a density higher than that of the other portion, and accordingly, has a higher airthightness, the peripheral portion is capable of exhibiting sealing function. Therefore, in this embodiment, no substantial leakage of the high-pressure steam injected from the surfaces of the hot platens through the lignocellulosic material takes place, and substantial portion of the steam is effectively absorbed, even if a resilient sealing means which is expensive and which is required

to be replaced depending upon frequency of use and working condition, for example, a resilient silicone sealing means is not disposed all around the lignocellulosic material, in contrast to the above-described embodiments. Incidentally, the injection of the high-pressure steam may be conducted stepwise by changing injection conditions (time, temperature, pressure, amount and the like).

The thus injected steam v penetrates from the surface of the lignocellulosic material W into the lignocellulosic material and even into the core portion thereof and is retained in the lignocellulosic material, thereby enabling intended treatment to be advanced. With respect to the above-mentioned treating conditions, optimum values are experimentally determined according to the kinds and dimensions of lignocellulosic materials to be treated, and the like. As regards most coniferous woods, it is preferred to maintain, during the injection of the high-pressure steam, the temperature of the platen at 150 to 250 °C, the pressure of the high-pressure steam at a level of several kgf/cm^2 to 30 kgf/cm^2, and the temperature of the high-pressure steam at about 150 °C to about 230 °C. When the supply of the high-pressure steam is stepwise conducted in the first and second steps, pressure of the high-pressure steam is preferably maintained at a level of about 5 kgf/cm^2 to about 7kgf/cm^2 in the first step and at a level of about 10 kgf/cm^2 to about 30 kgf/cm^2. The injection time of the high-pressure steam is preferably about 1 to about 10 min.

In the supply of the high-pressure steam, a chemical agent for chemical treatment such as acetylation or formallation, a chemical agent for plasticizing ammonia gas, a low molecular weight phenol or the like may be supplied simultaneously. These chemical agents penetrate uniformly throughout the whole lignocellulosic material together with the high-pressure steam.

In the above explanation, the initial thickness of the lignocellulosic material W is supposed to be larger than the height of the thickness regulating jig 3. However, the initial thickness of the lignocellulosic material disposed on the hot platen may be substantially equal to the thickness of an intended final product. In the case of a lignocellulosic material, such as a coniferous wood, which is required to be subjected to compaction treatment for densification and improved surface properties, it is preferred to employ a lignocellulosic material having a thickness larger than that of a final product, as shown in Fig.2. On the other hand, in the case of a lignocellulosic material, such as a particle board or an MDF, which requires no substantial compaction, a lignocellulosic material of substantially the same thickness as a final product is preferably employed. In this case, compaction treatment is effected only on the peripheral portions by the presence of frames 10.

After completion of the predetermined supply of the high-pressure steam, pressure release is conducted in substantially the same manner as above.

In another mode for carrying out this embodiment, supply of high-pressure steam from the surface of the hot platens 1a,1b is not conducted, and the lignocellulosic material is heated by the hot platens and/or high-frequency electric heating while vaporizing moisture in the lignocellulosic material. This mode is carried out by only heating by means of hot platens without supply of high-pressure steam when hot platens capable of supplying high-pressure steam are employed, by only heating by means of hot platens having no function for supplying high-pressure steam, or by only high-frequency electric heating or by heating with hot platens as well as high-frequency electric heating when conventional hot platens capable of performing high-frequency electric heating are employed. Other conditions are the same as in the first embodiment, and therefore overlapping explanation is eliminated.

It should also be understood that supply of high-pressure steam may be conducted in parallel with the heating.

According to the fourth embodiment of the present invention, a lignocellulosic material to be treated is placed in a rigid vessel which has temperature resistance and heat resistance and which is sealable, after a sheet member such as a resin sheet, a silicone rubber sheet or a release paper is put in the vessel if desired, and then the rigid vessel is disposed between hot platens and heated in a hermetically sealed condition.

There is no particular restriction with respect to the manner for bringing the rigid vessel containing the lignocellulosic material to a hermetically sealed condition and heating. For example, this treatment may be conducted by means of a conventional compression device having hot platens or may be conducted by means of a conventional roller press or belting press having heating means. In any case, it is effective from the view points of treatment in a shortened time and uniform treatment to employ high-frequency electric heating as a heating means. As a heating means, high-frequency electric heating may be employed alone or in combination with other heating means such as heating by hot platens.

The process for stabilizing a lignocellulosic material according to this embodiment will be described more in detail with reference to Figs.3 to 5.

The rigid vessel 20 used for the compaction preferably comprises two members separable in the direction of the compaction of a lignocellulosic material, for example, a vessel body 21 having an inner space S for receiving a lignocellulosic material and a flat lid 22, as shown in Fig.3. As a material for the rigid vessel 20, stainless steels are preferred. However, the material is not restricted to stainless steels. Any materials which have

resistance to temperature and pressure during compacting operation may be used. For example, iron materials, aluminum materials, heat resistant resins such as epoxy resins, silicone resins and polycarbonate resins, and the like may be used. In this connection, the vessel body 21 and the lid 22 are not necessarily made of the same material. For example, it is possible to form the vessel body from a stainless steel and the lid from a heat resistant resin such as an epoxy resin, a silicone resin or a polycarbonate resin. By this, there is an advantage that lightened weight of the rigid vessel as a whole is attained, leading to improved manageability.

A sealing means 23 preferably made of a heat resistant silicone is attached to the portion of the vessel body 21 which would otherwise be caused to abut directly upon the surface of the lid 22. Alternatively, as shown in Fig.5, a sealing means 23A made of, for example, a resilient silicone may separately be disposed all around the contained lignocellulosic material W. In this case, the sealing means 23 is not necessarily needed. The surfaces of the rigid vessel 20 which are brought into contact with the lignocellulosic material during treatment may be mirror-like surfaces in whole or in part, or may be so treated as to have fine irregularity. In the former case, a compacted lignocellulosic material with smooth and grossy surfaces can be obtained. In the latter case, a compacted lignocellulosic material having matte surfaces can be obtained.

Further, as shown in Fig.5, a sheet member 22A, for example, a resin sheet such as a Teflon sheet, a silicone rubber sheet, a release paper or the like, which has a thickness of 0.3 to 1.0mm, preferably 0.3 to 0.5mm, may be interposed between the bottom surface of the lid 22 and the lignocellulosic material W in such a manner that the sheet member entirely covers the opening of the vessel body 21, according to the purpose. Thereupon, a compacted lignocellulosic material having surface properties different from those of the rigid vessel (For example, the lid thereof) can be obtained, and yet release of the lignocellulosic material from the rigid vessel is facilitated and consequently operational efficiency is improved. Incidentally, the area of the sheet member 22A is preferably the same as or slightly larger than the cross-section of the rigid vessel 20. It is thereby possible to enhance sealing effect at the interface between the vessel body 21 and the lid 22. No particular illustrative designation is given in the drawings, however, a sheet member may be interposed also between the bottom surface of the vessel body 21 and lignocellulosic material W, if desired.

In the stabilizing method according to this embodiment, when a silicone rubber sheet is used as the sheet member 22A in the same manner as shown in Fig.5, there are attained effects that improved sealed condition in the vessel by virtue of tightly contacting properties of the silicone rubber sheet ensures prevention of leakage of steam evolved from the lignocellulosic material out of the rigid vessel, and as a result, a highly compacted product can be obtained, and that, by virtue of high elasticity of the silicone rubber sheet, a highly aesthetic compacted product can be obtained which has surface irregularities corresponding to the hardness distribution in the surface of the lignocellulosic material.

The cross-sectional figure of the space S formed inside the vessel body 21 may be any figure so long as it is capable of providing capacity for receiving the lignocellulosic material W to be treated. It is, however, practically preferred to select a cross-sectional figure somewhat larger than that of the lignocellulosic material, as shown in Fig.4. Although the dimensions in only one direction are shown in Fig.4, the inner width X of the vessel body 21 is somewhat larger than the width x of the lignocellulosic material W (,i.e.,$X > x$). On the other hand, the depth H of the vessel body is shallower (lower) than the thickness of the untreated lignocellulosic material (,i.e.,$H < h$).

For heat treatment of a lignocellulosic material W, the lid 22 is first removed from the rigid vessel 20, and a lignocellulosic material W to be treated is placed in the inner space S of the vessel body 21 [In this connection, (a) sheet member(s) 22A such as (a) silicone rubber sheet(s) may be disposed on the bottom of the vessel as described above and/or between the lid 22 and lignocellulosic material W as shown in Fig.5.] In this condition, a portion of the lignocellulosic material W in the thickness direction, namely, the (h-H) portion protrudes from the top of the vessel body 21. The vessel is then disposed between hot platens of a compression device, with the lid 22 mounted on the surface of the protruding portion of the lignocellulosic material W.

Also in this embodiment, as the hot platens, any customary hot platens used for compression of a lumber or preparation of a composite may be used. However, the hot platens are not restricted thereto. A conventional hot roller press or hot belting press may also be used. In this case, the rigid vessel containing the lignocellulosic material is placed on the upper part of such a press and moved downstream while being compressed and heated, thereby advancing the treatment. As heating means, high-frequency electric heating which includes microwave heating may be used alone or in combination with hot platens. In either case, a known microwave generator or high frequency generator is disposed in the vicinity of the lignocellulosic material to be treated.

In the treatment, after the rigid vessel 20 containing the lignocellulosic material is disposed, the hot platens 1a,1b are brought close until the upper hot platen abuts the rigid vessel 20 as shown in Fig.4 and further brought close until the lid 22 abuts the vessel body 21. The lignocellulosic material W is thereby compressed in the rigid vessel 20 and brought into a hermetically sealed condition. In this condition, heating by hot platens (in combination with high-frequency electric heating, if desired) is further continued. It is necessary to conduct

this heating at an adequately high temperature for causing moisture contained in the lignocellulosic material to be vaporized. The heating temperature may be changed stepwise. For example, the heating temperature is initially caused to stand at about 200, and then, gradually lowered with time or stepwise brought to a lower temperature after lapse of a predetermined time, thereby enabling discoloration of the surface of the lignocellulosic material due to the heat to be minimized. When high-frequency electric heating is employed in stead of or in combination with heating by hot platens, since moisture in a lignocellulosic material is uniformly vaporized, more uniform heat treatment can be effected and yet more shortened treatment cycle can be realized.

In this embodiment, as the lignocellulosic material W to be contained in the rigid vessel, one having an initial thickness substantially equal to the depth H of the inner space of the rigid vessel 20 may be used. In this case, the lignocellulosic material is subjected no substantial compaction treatment, and only heat treatment by vaporizing moisture contained in the lignocellulosic material.

After completion of the predetermined heating, pressure release is conducted in the same manner as in the other embodiments.

As described above, in the present invention, the depth (height) H of the inner space of the rigid leads to the thickness of the compacted lignocellulosic material. Accordingly, the depth H of the rigid vessel is appropriately determined according to an intended final product. However, even if vessel bodies having inner spaces of the same depth, it is possible to obtain compacted products having different thicknesses by laying a sheet (thin plate) member having heat resistance and pressure resistance on the bottom of the inner space, separately from the sheet member(s) mentioned above.

According to the fifth embodiment of the present invention, a sheet member or sheet members are interposed between the surface or surfaces of the lignocellulosic material and the hot platen or hot platens, and under this condition, said lignocellulosic material is heated by the hot platens.

In this embodiment, a mode in which a lignocellulosic material is held between hot platens in a hermetically sealed condition may be employed by appropriately following any of the above-described first to third embodiments.

As the sheet member, any of those having heat resistance may be used. Of such sheet members, appropriate one is selected according to the purpose. In addition, there is no particular restriction with respect to the thickness of the sheet member. However, the thickness is preferably 0.3 to 1.0mm, and particularly preferred is 0.3 to 0.5mm. As examples of the sheet member, for example, to enhance aesthetic value of a compacted lignocellulosic material by applying modification to the surface of the lignocellulosic material, there may preferably used a sheet member having its surface appropriately embossed, for example, an embossed resin film such as epoxy resin film or phenolic resin film, or an embossed sheet such as silicone resin sheet; to improve release properties of a compacted lignocellulosic material from a platen, there may preferably used a Teflon sheet, a silicone-coated paper or a release paper; and to attain improved sealed condition, there may preferably used a silicone rubber sheet.

In particular, when a silicone rubber sheet is used as the sheet member, there are attained effects that highly airtight properties and tightly contacting properties of the silicone rubber sheet enable to more enhanced sealed condition between the sealing means disposed all around the lignocellulosic material and the hot platen to be established and accordingly enables prevention of leakage of steam evolved from the lignocellulosic material out of the rigid vessel to be ensured and consequently enables a highly compacted product to be obtained, and at the same time that, owing to the elasticity of the silicone rubber sheet, a highly aesthetic compacted product can be obtained which has surface irregularities corresponding to the hardness distribution in the surface of the lignocellulosic material.

The process for stabilizing a lignocellulosic material according to this embodiment will be described more in detail with reference to the Figs.6 and 7.

Fig.6 shows a condition in which sheet members are further disposed in the first or second embodiment of the process for stabilizing a lignocellulosic material. On the lower hot platen 1a of a pair of the hot platens 1a,1b is disposed a sheet member S, On the sheet member S, a lignocellulosic material W sized into a predetermined thickness and predetermined dimensions is placed. Then, all around the lignocellulosic material W is disposed a resilient sealing means 2 somewhat higher than the thickness of the lignocellulosic material as a final product, and around the sealing means (is) are disposed (a) thickness regulating jigs 3 having a height equal to the thickness of the lignocellulosic material as an intended final product. Then, a sheet member S'is disposed thereon in such a manner that the sheet member S' covers the at least above-mentioned resilient sealing means 2 disposed all around the lignocellulosic material W. The sheet member S' may be of the same material as, or may be of a material different from that of the sheet member S which has already been disposed. As mentioned above, they are appropriately selected according to the purpose.

The material for the resilient sealing means 2 may be any of materials so long as they have sealing function capable of preventing the steam evolved from inside of the lignocellulosic material by the heating of the ligno-

cellulosic material W from leaking out, and they have heat resistance and compressive properties as well. As already mentioned, a resilient packing made of a silicone is particularly preferred. As a material of the thickness regulating jig, any materials may be used so long as they have requisite rigidity and heat resistance. Of these, aluminum alloys and stainless steels are preferred, and stainless steels are particularly preferred.

In the treatment, to the sheet member S, the lignocellulosic material W, the resilient sealing means 2 and the thickness regulating jig(s) 3 arranged on the hot platen 1a, and the sheet member S' further disposed thereon, the other hot platen 1b is brought close until it abuts upon the sheet member S', followed by the same subsequent procedure as in the other embodiments already described. As heating means, high-frequency electric heating may be employed instead of the heating by platens, which is also the same as in the embodiments already described. After completion of the predetermined heating, pressure release is conducted as described in the above.

In this embodiment, various effects are provided by virtue of the interposition of the sheet members S and S' between the surfaces of the lignocellulosic material W and hot platens 1a and 1b, respectively. For example, surface properties of a compacted lignocellulosic material depend upon the surface properties of the sheet members independently of the surface properties of the hot platens. In other words, even if a hot platen having a mirror-like surface is used, a highly aesthetic compacted lignocellulosic material having a matted surface or a surface with irregularities can be obtained by using an appropriately irregularity-provided (embossed) sheet member. On the other hand, even if a platen having a surface with minute irregularities caused by, for example, being damaged, a lignocellulosic material having a smooth and glossy surface can be obtained by using a sheet member having a smooth surface such as a PET resin sheet.

Further, even if a compacted lignocellulosic material subsequent to the heat treatment is not smoothly released from a platen due to surface conditions of the lignocellulosic material to be treated or conditions of the heat treatment, the release can be facilitated, and consequently, lowering of efficiency of the treatment can be avoided by using a sheet member such as a silicone-coated paper or a release paper.

Moreover, since the airtight condition is further improved by the interposition of the sheet, steam evolved from the inside of the lignocellulosic material is satisfactorily prevented from leaking out. This enables the compaction to be more facilitated. In particular, when silicone rubber sheets are used as the sheet members S,S', highly airtight properties and tightly contacting properties of the silicone rubber sheets enable to improved sealed condition established, and at the same time, owing to the high elasticity of the silicone rubber sheets, a highly aesthetic compacted product can be obtained which has surface irregularities corresponding to the hardness distribution in the surface of the lignocellulosic material.

Fig.7 shows a condition in which sheet members are further disposed in the above-described third embodiment of the process for stabilizing a lignocellulosic material. The resilient sealing means 2 used in the method in Fig.6 is not employed, and frames 10 made of an aluminum material, a stainless material or the like are instead disposed on the peripheral portions of the top and bottom surfaces of the lignocellulosic material W. The thickness regulating jigs 3 are disposed along only two opposite sides of the lignocellulosic material W. Other points than these are the same as the case in Fig.6.

It is readily understood that, also in this embodiment, the sheet member disposed on the hot platen 1a and the sheet member S' disposed on the lignocellulosic material W exhibit the same function and enable the same effect to be attained as explained in the case of Fig.1.

In this embodiment, it is not necessarily required to dispose sheet members on both sides of a lignocellulosic material which face hot platens. The compaction may be conducted with a sheet material disposed on one surface of the lignocellulosic material. Further, the hot platen-heating is not restricted to heating by both upper and lower hot platens. Depending upon the thickness of the lignocellulosic material, applications of the compacted lignocellulosic material and the like, heating by one of the platens may be conducted. In this case, a sheet member is disposed, of course, on the surface facing a hot platen to be heated.

According to the sixth embodiment of the present invention, a sheet member having absorptivity is used as the above-mentioned sheet member. By this, a process for compacting a lignocellulosic material is provided which is capable of preventing the surface of a compacted lignocellulosic material from being stained with a resinous substance. The process according to this embodiment is particularly effective in a case where a lignocellulosic material to be treated is a veneer. However, intended end can be attained not only in the case of a veneer but also in a case where the process is applied to any of lignocellulosic materials, for example, those from which a resinous substance is likely to ooze such as a wood sheet and a lumber, materials prepared by reprocessing an intermediate material such as a particle board and the like. Further, there is no particular restriction with respect to the thickness of the lignocellulosic material to be used. It is confirmed from experience that oozing of a resinous substance out of a thin lignocellulosic material of 0.2mm to 0.5mm is likely to be marked. However, the present invention satisfactorily acts even on such a thin lignocellulosic material.

As the sheet having absorptivity, any sheets capable of absorbing a resinous substance may be used. Of

these, a paper and a fabric are effectively used. As the paper, a Japanese paper is particularly effective. Th fabric may be a woven fabric or non-woven fabric.

Thickness of the sheet having absorptivity is dependent primarily on the absorptivity of the sheet and the amount of the resinous substance oozing from the lignocellulosic material during compaction. in general, about a thickness of 0.1mm to about 1,0mm is sufficiently operative irrespective of the material of the sheet. When a Japanese paper is used, even a thickness of about 0.2mm is operative enough. If the sheet has a thickness of less than about 0.1mm, absorption of the resinous substance is likely to be inadequate. If the sheet has a thickness of larger than about 1.0mm, the cost is high, and yet a disadvantage is caused in a space where the sheet serves also as a backing as described below. The sheet having absorptivity may be impregnated with a solvent for the resinous substance. As the solvent, an alcohol such as methanol, a ketone such as methyl ethyl ketone may effectively be used.

When compaction treatment is conducted with the sheet having absorptivity disposed on the surface of the lignocellulosic material, the sheet sometimes adheres to the surface of the lignocellulosic material by the resinous substance oozing from the inside of the lignocellulosic material during compaction. With a view to avoiding this, it is desired to use a sheet having its surface(s) coated with a substance having release properties such as a silicone. It is thereby facilitated to remove the sheet, to which the resinous substance has been transferred, from the surface of the lignocellulosic material at the end of the compaction treatment. Of course, a woven fabric or a non-woven fabric as the sheet originally has release properties to some extent, and therefore, may be used by itself without coating with a substance having release properties.

It is also possible to positively utilize the adhesion of the sheet to the surface of the lignocellulosic material with the substance oozing from the inside of the lignocellulosic material by the compaction. In other words, when a compacted lignocellulosic material is used as a facing material for furniture or the like, there are of course one surface to be the face and the other to be the rear. The compaction is conducted with a releaser-treated sheet disposed on the surface to be the face and with an untreated sheet is disposed on the surface to be the rear. With respect to the face, the resinous substance is transferred to the absorptive sheet and the sheet is unfailingly removed from the surface of the lignocellulosic material, and consequently, an unstained beautiful surface can be obtained. With respect to the rear, since the sheet remains adhering to the surface of the lignocellulosic material, the rear of the lignocellulosic material is just provided with a backing. In particular, when a thin veneer is subjected to the compacting treatment, the backing serves as a reinforcement to enable lathe check to be effectively prevented.

In this embodiment, particular effect can be attained by interposing (an)absorptive sheet(s) which has (have) been impregnated with water between one or both surface(s) of a lignocellulosic material to be treated and (a) hot platens. In other words, since woods have different average moisture contents according to the kind of trees, some kinds of woods as such have moisture content required for the compacting treatment. In such cases, it is impossible to obtain a compacted lignocellulosic material having sufficient dimensional stability. In particular, this problem is likely to be caused when a thin veneer is treated. To cope with such problem, it is effective that (a) sheet(s) is (are) preliminarily impregnated with a predetermined amount of water and disposed on (a) surface(s) of a lignocellulosic material to be treated, and then compacting treatment is conducted. As a result, it is ensured that a compacted lignocellulosic material excellent in dimensional stability is obtained.

Incidentally, such (an) absorptive sheet(s) may be disposed on one surface or both surfaces of a lignocellulosic material according to the purpose.

The specific procedure for preparing a compacted lignocellulosic material is substantially the same as that in any of the above-mentioned embodiments, in particular the fifth embodiment, and accordingly, explanation on the procedure is omitted.

According to the seventh embodiment of the present invention, a sheet member is disposed between each surfaces of a lignocellulosic material to be treated and each hot platen, and around the lignocellulosic material to be treated is disposed only a thickness regulating jig made of a material having requisite rigidity and heat resistance, and under this condition, heating of the above-mentioned lignocellulosic material is conducted by means of the hot platens.

That is, in this embodiment, the compacting treatment is conducted without the rigid sealing member used in each of the above-mentioned first to sixth embodiments. In the above-mentioned embodiments, with respect to the cases where the stabilizing treatment of a lignocellulosic material is conducted with a sheet member such as a silicone rubber sheet disposed between each of surfaces of the lignocellulosic material and hot platens, required sealed condition can be maintained at the interfaces between each of sheet members and the thickness regulating jig having rigidity without disposing a resilient sealing means made of, for example, a resilient silicone between the hot platens, and consequently, a treated product which has been sufficiently compacted can be obtained. Fig.8 shows one mode of this embodiment. In this mode, on the lower hot platen 1a of a pair of the hot platens 1a,1b is disposed a sheet member S. On the sheet member S, a lignocellulosic ma-

terial W sized into a predetermined thickness and predetermined dimensions is placed. Then, all around the lignocellulosic material W is disposed a is disposed a frame-like thickness regulating member 3 as shown in Fig.9. Then, a sheet member S'is disposed thereon in such a manner that the sheet member S' covers the above-mentioned thickness regulating member 3, followed by substantially the same treatment as in any of the other embodiments.

The material of the thickness regulating member is required to have resistance to pressure and temperature at the time of the compacting treatment. As the material having the requisite rigidity (pressure resistance) and heat resistance, there may be mentioned a metal such as a stainless steel and an aluminum alloy, and a synthetic resin such as a polycarbonate resin and an epoxy resin. When high-frequency electric heating which includes microwave heating (hereinafter referred to simply as "high-frequency electric heating") is employed as heating means, a thickness regulating member made of a synthetic resin is effectively used.

For the sheet member, any of materials may be used so long as they have heat resistance and low permeability to steam. For example, a silicone sheet a Teflon sheet, a polyimide sheet, and a polyether ether ketone (PEEK) sheet may preferably used. These sheets preferably have a thickness of about 0.3 to about 1.0mm, more preferably about 0.3 to about 0.5mm. A silicone rubber sheet is particularly preferred, which ensures satisfactory sealing condition between the thickness regulating member disposed around the lignocellulosic material and the hot platens to enable steam evolved from the inside of the lignocellulosic material to be prevented from leaking out.

As mentioned above, in the process for stabilizing a lignocellulosic material according to this embodiment, a member having buffering properties such as a resilient sealing means other than the thin sheet members is not disposed between the hot platens. Accordingly, positioning of the hot platens is required to be more precise than that in a conventional method. It is, therefore, particularly recommended to use a controlling mechanism such as a mechanism which is used in a conventional compression machine and which measures the distance between hot platens to control the movement of the hot platens based on the measured values or a mechanism which controls the movement of hot platens by a servo motor, in combination with the hot platens.

In addition, although there is no illustrative designation is given in the Fig., a vessel-shaped member with a bottom may be used as the thickness regulating member. In this case, a sheet member may be placed on the bottom of the vessel-shaped member. Incidentally, the smaller the distance between the lignocellulosic material and the thickness regulating member all around the lignocellulosic material, the higher the compaction effect.

In the above-mentioned several embodiments for carrying out the process for stabilizing a lignocellulosic material according to the present invention, the compacting treatment is basically conducted batchwise. In other words, one cycle comprises a step for disposing a lignocellulosic material between hot platens of a compression device, a step for compacting the lignocellulosic material by hot platens, if desired, while supplying high-pressure steam from the surface of the hot platens toward the lignocellulosic material, a step for bringing the hot platens distant posterior to pressure release, a step for removing the lignocellulosic material and the like, and this cycle is repeated as a basic procedure. Although the time for one cycle is shortened, it takes 20 to 30 min to complete one cycle. According to the eighth embodiment of the present invention, the compacting treatment is conducted continuously to enable treating time to be shortened.

According to this embodiment, there is provided a process for stabilizing a lignocellulosic material which comprises:

holding a lignocellulosic material between hot platens in a sealed condition, and

heating the lignocellulosic material to vaporize moisture contained in the lignocellulosic material per se; thereby effecting high-pressure steam treatment of the lignocellulosic material,

wherein between endless belts adapted to have at least in part a opposed zone and to be such that the opposed surfaces travel in the same direction, which function as a pair of hot platens, the lignocellulosic material is fed with a resilient sealing member and, if desired, a thickness regulating jig disposed around the lignocellulosic material, and the lignocellulosic material is heated in the course of being caused to pass through the opposed zone between the endless belts.

This process may further comprise a step for preliminarily compressing and, if desired, preliminarily heating the lignocellulosic material by one or more hot rolls as a pre-step prior to the passage of the lignocellulosic material through the opposed zone between the pair of endless belts. In this case, it is possible to reduce compression force of press means located in the opposed zone between the pair of endless belts or to eliminate such compression by the press means, as described below.

In addition, this process may further comprise a step for supplying a high-pressure steam toward said lignocellulosic material during the passage of the lignocellulosic material through said opposed zone between the pair of endless belts. In this case, recovery ratio of a compacted lignocellulosic material is further lowered as described below.

Further, the lignocellulosic material may be maintained at a high t mperature of about 150 °C to about 250 °C to establish a so-called hot condition and then maintained at a low temperature of 100 °C or lower, preferably 80 °C or lower to establish a so-called cold condition during the passage of the lignocellulosic material through said opposed zone between the pair of endless belts. By this, the recovery ratio is further lowered as described below.

Now, the process for stabilizing a lignocellulosic material according to this embodiment and a device suitable for carrying out the process will be described more in detail with reference to the accompanying drawings.

Fig.10 shows one form of a device for stabilizing treatment of an endless belting press type, which is preferably used for carrying out the process for preparing a compacted lignocellulosic material according to the present invention. This device for stabilizing treatment comprises an upper endless belt 110 and a lower endless belt 120, and the upper endless belt 110 travels around a set of a driving roller 111 and a driven roller 112, and the lower endless belt 120 travels around a set of a driving roller 121 and a driven roller 122 which have a longer center distance as shown in Fig.10. The driving rollers 111 and 121 rotate in such directions that their rotations respectively cause the opposite surfaces of the upper endless belt 110 and the lower endless belt 120 to move in the same direction (the direction of the arrow A in Fig.10). In the upper endless belt 110, a large number of through-holes H are perforated (see Fig.11). In this connection, as described below, when no high-pressure steam is supplied toward the lignocellulosic material, the through-holes H are not necessary.

Between the driving roller 111 and the driven roller 112 of the upper endless belt 110 is located a frame 115 supported by a device frame (not shown), and to the frame 115 are attached plurality of (in Fig.10, four) hydraulic actuator 130 having a cylinder 131 and a piston 132, and to the distal end of each of the piston is attached a press roll 133 having a length substantially equal to the width of the upper endless belt 110. The upstream three of the press rolls 133 are provided with built-in electric heaters 134a, and the most downstream press roll is formed with cooling water circulating paths 134b.

Each of the hydraulic actuators 130 is connected to a hydraulic pressure source (not shown) via a valve mechanism and separately exerted an adjustable hydraulic pressure. The electric heaters 134a embedded in the press roll 133 are separately temperature-controlled by a controlling mechanism (not shown). In the vicinities of the upstream press rolls 133 are disposed nozzles 135 for steam injection, and the tip of each of the nozzles is located adjacently to the inner surface of the endless belt 110, and the other end thereof is connected to a pressurized steam supplying device (not shown) via a valve mechanism (not shown). Around the press rolls located downstream from the nozzles 135 (in Fig.10, the three press rolls other than the most upstream press roll) is mounted a flat belt M for sealing which is made of a heat resistant material such as a stainless steel, and as described below, the flat belt M is adapted to co-rotate consequently upon the rotation of the upper endless belt 110 when caused to abut upon the upper endless belt 110 by the action of the actuators 130.

As shown in Figs.11 and 12, to the peripheral surface of the lower endless belt 120, right and left two resilient sealing members 123,123 are unifically attached with a distance somewhat wider than the width of a lignocellulosic material W by an appropriate adhesive throughout the perimeter, and resilient sealing members 124 made of the same material are also unifically attached between the resilient sealing members 123,123 with a distance somewhat longer than the length of the lignocellulosic material W. The height of the resilient sealing members is selected to be somewhat higher than the thickness of an intended compacted lignocellulosic material. Further, outside each of the resilient sealing members 123,123, each of two thickness regulating jigs 125,125 is also unifically attached. the height of the thickness regulating jigs is selected to be substantially equal to the thickness of the intended compacted lignocellulosic material. In this connection, as apparent from the description given below, when the distance between the carrying surface of the lower endless belt 120 and the press roll 133 of the above-mentioned actuator 130 can be maintained at the predetermined value by controlling the travel of the piston 132 of the actuator 130 by means of any controlling mechanism, the above-mentioned thickness regulating jigs are not necessary.

As a material for the above-mentioned resilient sealing members, any materials may be used so long as they have sealing function capable of preventing the steam from leaking out which is evolved from inside of the lignocellulosic material during the heating and compaction of the lignocellulosic material in the endless belting press, and they have heat resistance and compressive properties as well. However, a resilient packing made of a silicone is particularly preferred. As a material of the thickness regulating jigs which are mounted according to need, any materials may be used so long as they have requisite rigidity and heat resistance. Of these, aluminum metals and stainless steels are preferred, and stainless steels are particularly preferred. In the thickness regulating jig, slits 126 are formed at predetermined intervals throughout its length to readily follow the curvature of the lower endless belt when the lower endless belt 120 travels along the driving roller 121 and the driven roller 122.

In Fig.10, 150 represents a supporting stand for a lignocellulosic material to be supplied, and 160 repre-

sents a supporting stand used for a removed compacted lignocellulosic material.

In the next place, the process for compacting a lignocellulosic material by means of this device for stabilizing treatment of the endless belting press type will be described. Lignocellulosic materials W sized into a predetermined thickness and predetermined dimensions are placed on the supporting stand 150, and each of the lignocellulosic material W is placed into a space S (Fig.12) defined by the resilient sealing members 123,124 mounted on the lower endless belt 120 which is continuously traveling. The thus placed lignocellulosic material W is transferred in the direction of arrow A in Fig.10 to reach the region where the upper endless belt 110 and the lower endless belt 120 face each other.

The upper endless belt 110 is pressed against the lower endless belt 120 via the press rolls 133 by the action of the actuators 130, and the thus brought lignocellulosic material W and resilient sealing members 123,124 are gradually compressed until the compressing movement is restricted by the thickness regulating jig 125 while being transferred from the upper course to the lower course, and under the compressed condition, further transferred downstream and released from the pressure when transferred past the most downstream press roller 133 and finally brought the supporting stand 160.

In the course of the compression, the lignocellulosic material W is heated by heaters 134a mounted in the upstream rotary rollers 133. Further, pressurized steam is supplied in a predetermined amount (for a predetermined period of time) from the steam injecting nozzles 135 by operating a controlling mechanism (not shown), if desired. In this case, as the upper endless belt 110, one formed with a large number of through-holes H by perforation as shown in Fig.11 is used. The supplied pressurized steam enters the space surrounded by the upper and lower endless belts and the resilient sealing members located on four sides through the through-holes H formed in the endless belt 110. In the upper course from the steam injecting nozzles 135, the through-holes H are obstructed by the action of the above-mentioned flat belt M for sealing, and consequently, the entered pressurized steam penetrates into the lignocellulosic material and even into the core portion thereof, thereby enabling intended treatment to be advanced.

With respect to the conditions for the above-mentioned pressurized steam supply, optimum values are experimentally determined according to the kinds and dimensions of lignocellulosic materials to be subjected to the steam, and the like. As regards most coniferous woods, it is preferred to maintain, during the injection of the pressurized steam, the temperature of the press rolls 133 at 150 °C to 250 °C, the pressure of the pressurized steam at a level of several kgf/cm^2 to 30 kgf/cm^2, and the temperature of the pressurized steam at about 150 °C to about 250 °C. The supply of the pressurized steam may be stepwise conducted in a plurality of steps. For example, when the supply of the pressurized steam is stepwise conducted in the first and second steps, the first supply of the pressurized steam is conducted at the initial stage where the upper endless belt 110 abuts upon the lignocellulosic material W (namely, the stage where the rotary rollers 133 is not yet in contact with the thickness regulating jigs 125) to partially soften the lignocellulosic material, and the second supply of the pressurized steam is conducted at the stage where the press roller(s) 133 located in the lower course is (are) in contact with the thickness regulating jigs 125. The pressure of the pressurized steam is preferably at a level of about 5 kgf/cm^2 to about 7kgf/cm^2 in the first step and at a level of about 10 kgf/cm^2 to about 30 kgf/cm^2 in the second step. The injection time of the pressurized steam is preferably about 1 to about 10 min.

In the supply of the high-pressure steam, a chemical agent for chemical treatment such as acetylation or formallation, a chemical agent for plasticizing ammonia gas, a low molecular weight phenol or the like may be supplied simultaneously. These chemical agents penetrate uniformly throughout the whole lignocellulosic material together with the pressurized steam.

Also in this embodiment, the initial thickness of the lignocellulosic material disposed on the lower endless belt 120 may be substantially the same as the thickness of an intended final product, or may be up to about 300% of the same. Further, in the case of a material which is prepared by reprocessing an intermediate material, such as an MDF or a particle board, the treatment according to the present invention may be effected during the step for forming into a lignocellulosic material, or may be effected as post-treatment on a material which has already been formed as a lignocellulosic material.

With respect to the length of the zone where the upper endless belt 110 and the lower endless belt 120 face each other and traveling speed of each of the endless belts, optimum values are experimentally selected taking kinds and dimensions of lignocellulosic materials to be treated, characteristics of intended final products and the like into consideration. The endless belts may be caused to travel intermittently, by which the compaction time and the time for supplying the pressurized steam may appropriately be adjusted.

The lignocellulosic material which has been subjected to the predetermined compaction and, if desired, the exposure to the pressurized steam is released from the pressure when transferred past the most downstream rotary roller 133, and further transferred downstream, finally, to the supporting stand 160.

In the above description, since the upstream three of the press rollers 133 disposed between a pair of the endless belts is maintained at a high temperature and the downstream roll is maintained at a low temperature,

the lignocellulosic material is changed from high temperature state to low temperature state in the course of the passage between the pair of the endless belts. Thus, compaction by a so-called hot-cold method may be conducted. By this, a final product whose dimensional change is small and which has smooth surface condition can be obtained. According to the experiments of the present inventors, a compacted lignocellulosic material having further diminished dimensional change and more smoothened surface condition can be obtained by controlling the temperature of the heating means (in this embodiment, the temperature of the press rolls) and the traveling speed of the lignocellulosic material in such a manner that the lignocellulosic material under treatment is maintained at a high temperature state (hot state) of about 150 °C to 250 °C in the upper course and then maintained at a low temperature state (cold state) of about 100 °C or lower, preferably about 80 °C or lower.

Incidentally, depending upon the kind of a lignocellulosic material or characteristics of an intended final product, it is not necessarily required in some cases to conduct compaction in a hot-cold method. In such cases, the downstream press roll maintained in a cold state is not required, and compaction is conducted using press rolls 133 all of which are provided with heaters.

In another mode, the heating of the lignocellulosic material may be conducted by means of a separately provided means for high-frequency electric heating (not shown) alone without using heaters mounted in press rolls, or in combination. Further, the heater mounted in the press roll is not restricted to an electric heater, and may be of a type using a circulated oil or steam. The press rolls may be maintained at the same temperature or set at different temperatures.

Further, it is not necessarily required to attach the rotary press roll 133 to the distal end of the hydraulic actuator 130 located between the driving roller 111 and the driven roller 112 of the upper endless belts. A flat plate, a block having a curved bottom surface or the like may be attached alone or in combination with a press roll, provided that the lignocellulosic material is moved smoothly. In particular, when a pressing member having a flat bottom surface, it is possible to obstruct the through-holes H formed in the upper endless belt 110 by the pressing member, and accordingly the flat belt M for sealing as in the case of Fig.10 is not necessary.

Further, in the form shown in Fig.10, only the upper endless belt is provided with the hydraulic actuators 130 and the lower endless belt is provided with a flat plate support member. However, the lower endless belt 120 may also be provided with similar hydraulic actuators at the positions opposite to the hydraulic actuators 130 attached to the upper endless belt, thereby enabling a lignocellulosic material to be compressed and heated from both sides. In this case, it is preferred that a large number of through-holes are formed in the lower endless belt 120 as in the upper endless belt 110 and that a flat belt is mounted or flat plate pressing members are used to effect necessary obstruction of the through-holes in the same manner as above. In this case, it is not necessary to attach a flat plate supporting member to the lower endless belt. Also in this case, if no pressurized steam is supplied toward the lignocellulosic material, it is not necessary to form the through-holes.

Then, another form of the device for stabilizing treatment of a endless belting press type will be described with reference to Fig.13. In this device for stabilizing treatment, a plurality of hot rolls 170 are located above a region of the carrying surface of the lower endless belt 120, which does not face the upper endless belt 110. Each of the hot rolls 170 is attached to each of hydraulic actuators 175 which is attached to the frame 171 fixed to a device frame (not shown) and which comprises a cylinder 172 and a piston 173. Each of the hot rolls 170 has a length substantially equal to the width of the lower endless belt 120 and is provided with built-in electric heaters 176. Each of the hydraulic actuators 175 is connected to a hydraulic pressure source (not shown) via a valve mechanism and separately exerted an adjustable hydraulic pressure. The electric heaters 176 embedded in each of the hot rolls 170 are separately temperature-controlled by a controlling mechanism (not shown) according to need.

The process for preparing a compacted lignocellulosic material using this device for stabilizing treatment is different from the preparation process described with reference to Figs.10 to 12 in the following point. That is, a lignocellulosic material W is preliminarily compressed and heated by the above-mentioned hot rolls 170 as a pre-treatment step, before the lignocellulosic material W is caused to pass through the zone where the upper endless belt 110 and the lower endless belt 120 face each other. Conditions for the preliminary compression and the preliminary heating vary depending upon the kind of a lignocellulosic material and characteristics of a final product. Therefore, a preferred form of the device is so constructed as to be capable of exerting a compression force in a range of preferably from 10 to 200 kgf/cm^2 and capable of establishing a temperature in a range of about 100 °C to about 300 °C.

By providing the hot rolls for the preliminary compression and the preliminary heating, compression force requisite for the hydraulic actuators 130 located between the driving roller 111 and the driven roller 112 of the upper endless belt 110 can be greatly relieved, and in some cases, the compression (by the hydraulic actuators) in the zone is not needed. Consequently, construction of the device as a whole can extremely be simplified and cost for equipment can be reduced.

There is no particular illustrative designation is given in Fig.13, however, also in this form, the low r endless belt 120 may be provided with similar hydraulic actuators 170 on the reverse surface thereof at the positions opposite to the above-mentioned upper hydraulic actuators 170, thereby enabling a lignocellulosic material to be preliminarily compressed and heated from both sides. In this connection, relative to this site, it is not necessary to attach a flat plate supporting member to the lower endless belt.

Then, still another mode will be described. In this mode, on a supporting stand 150 are put a number of sets of a substrate 1110, which is made of a material having pressure resistance and heat resistance such as a stainless steel plate, and a lignocellulosic material W, a resilient sealing member 1230 around the lignocellulosic material and thickness regulating jigs outside the resilient sealing member which are arranged on the substrate as shown in Fig.14. The sets are successively fed to an endless belting press. As a device for preparing a compacted lignocellulosic material of an endless belting press type, those described above may appropriately be used. In this connection, it is not necessary to mount the resilient sealing members 123,124 and the thickness regulating jigs 125 on the lower endless belt. The procedure of the compaction is conducted in the same manner as in the above-mentioned modes.

According to this mode, the construction of the endless belting press, in particular the construction of the lower endless belt 120 is simplified, and it is possible to cope with compaction relative to lignocellulosic materials of different sizes.

The present invention will be described with reference to Examples.

[Example 1]

Each of lignocellulosic material samples was compacted and sealed between a pair of hot platens, then heated by the platens. As the lignocellulosic material samples several pieces of sugi lumber, each having a moisture content of 20% and a size of 30 mm thick, 150 mm wide and 600 mm long, were prepared. The samples were divided into four groups, and the treatment according to the present invention was carried out.

For all groups, each sugi lumber was placed on the lower platen of a compression device. All around the sugi lumber was disposed an elastic silicone piece of 32 mm high and 30 mm wide as a sealing member, and all around the sealing member was disposed a stainless steel piece of 12 mm high and 50 mm wide as a thickness regulating jig. The platens were set to be 200 °C, and then moved to be brought into contact with the sugi lumber, thereby effecting primary heating for 5 min. Then, the compression device was operated to bring the hot platens close until the movement of the hot platen was restricted by the thickness control jig, thus gradually compacting the lignocellulosic material. The sugi lumber was thereby compacted to a compaction ratio of about 60%.

Under this condition, Group 1 and Group 2 samples were heated at 200 °C for 10 min by the hot platens as secondary heating. Then, Group 1 samples were gradually released from the pressure over a period of 5 min. Group 2 samples were gradually released from the pressure over a period of 5 min by supplying cooling water to the hot platens. Group 3 and Group 4 samples were heated at 200 °C for 20 min by the hot platens also as secondary heating. Then, Group 3 samples were gradually released from the pressure over a period of 5 min. Group 4 samples were gradually released from the pressure over a period of 5 min by supplying cooling water to the hot platens.

Each of the final products after the pressure release was boiled in a boiling bath for 2 hr and then completely dried. The thickness of the each resultant was measured, and the thickness swelling ratio and recovery ratio in the radial direction were determined in an edge portion and a central portion. The results are shown in Table 1, No.1-4 in accordance with the following equations.

$$\text{Thickness swelling ratio} = (\text{thickness after 2 hr boiling} - \text{initial dry thickness})/(\text{initial dry thickness}) \times 100\ \%$$

$$\text{Recovery ratio} = (\text{thickness after 2 hr boiling} - \text{thickness after compaction})/(\text{thickness before compaction} - \text{thickness after compaction}) \times 100\ \%$$

The time required for the entire procedure of treatment of each of the sugi lumbers was determined for each group. The results are also shown in Table 1, No.1-4.

The surfaces of the thus obtained products were very stiff, smooth and beautiful.

[Comparative Example 1]

Sugi lumbers of the same size as in Example 1 were heat-softened by soaking in water at 95 °C for 20 min (boiling treatment) as a first step , and then compacted to 60% compaction ratio by a heat-compression device heated to 105°C. Then, the sugi lumber were divided into two groups. As a second step, treatment with hot, high-pressure steam was conducted by means of an autoclave while being restrained from undergoing

deformation by the stainless steel jigs, over a period of 4min for Group 1 and 8min for Group 2. The steam was 10 kgf/cm^2 and temperature in the autoclave was 180 °C. With respect to each of the Groups, the pressure in the autoclave was released gradually to obtain treated lignocellulosic material samples.

With respect to each of the Groups, the thickness swelling ratio and recovery ratio in the radial direction were determined for edge portions and central portions in the same manner as in Example 1. The results are shown in Table 1, No. 5-6.

The time required for the entire procedure of treatment of each of sugi lumbers was determined for each group. The results are shown in Table 1, No.5-6.

The surfaces of the thus obtained products were stiff, but not as much as in Example 1. Also, the appearance was poor distinctly.

[Example 2]

Several pieces of white oak sapwood each having a moisture content of 10%, and size of 15 mm thick, 150 mm wide, and 600 mm long were prepared and divided into four groups. The same treatment as in example 1 was applied to all groups, except that thickness a stainless steel of 15 mm high and 50 mm was placed as a thickness regulating jig and that the first step including compaction treatment was omitted. The thickness swelling ratio in the radial direction and treatment cycle were determined in the same manner as in Example 1. Table 1, No. 7-10 shows the results.

The surfaces obtained products were very stiff, smooth, and beautiful as those in Example 1.

[Comparative Example 2]

White oak sapwood pieces of the same size as in Example 2 were divided into 2 groups. The same treatment as in Comparative Example 1 was applied to these. groups, except that boiling and compaction treatments were omitted and that a stainless steel of 15 mm high and 50 mm wide was placed as a thickness regulating jig. The thickness swelling ratio in the radial direction and treatment cycle were determined in the same manner as in Example 1. The results are shown in Table 1, No. 11-12.

The surfaces of the obtained products were stiff but not as much as in Example 2. Also, the appearance was poor distinctly.

[Comparative Example 3]

The same white oak sapwood pieces as used in Example 2 were boiled in a boiling bath for 2 hr as such and their thicknesses were measured and thickness swelling ratio in the radial direction was determined. The results are shown in Table 1, No. 13.

The surfaces of the obtained products were stiff but not as much as in Example 2. Also, the appearance was poor distinctly.

[Discussion on Table 1]

As is apparent from Table 1, the lignocellulosic materials subjected to the treatment according to the present invention showed in most cases superior properties of radial thickness swelling and recovery ratios to those treated by an autoclave, thus showing improved dimensional stability. Significance of the present invention is evidenced by the improvements in the thickness swelling ratio and recovery ratio in the central portions for all cases. In particular, the so-called hot-cold treatment was effective.

The time for the treatment was also shortened, resulting in higher productivities.

Also, the surface condition was extremely excellent as compared with the other cases.

Table I

	first step		(compaction)	second step		pressure release method	result				
							thickness swelling ratio		recovery ratio		treatment cycle
	temperature	time	cpmpaction ratio	temperature	time		edge	center	edge	center	
	℃	min.	%	℃	min.	5 min.	%	%	%	%	min.
Ex. 1											
1	200	5	60	200	10	gradually	35	33	23	22	20
2	200	5	60	200	10	cold	29	27	19	18	20
3	200	5	60	200	20	gradually	6	8	0	0	30
4	200	5	60	200	20	cold	3	3	0	0	30
Comp. Ex. 1				(steam)							
5	boiling treatment		60	10kg/cm²	4	gradually	33	81	22	54	39
6	boiling treatment		60	10kg/cm²	8	gradually	8	36	0	24	43
Ex. 2											
7	—	—	0	200	10	gradually	15	13	—	—	15
8	—	—	0	200	10	cold	11	9	—	—	15
9	—	—	0	200	20	gradually	7	7	—	—	25
10	—	—	0	200	20	cold	3	2	—	—	25
Comp. Ex. 2				(steam)							
11	—	—	0	10kg/cm²	4	gradually	14	18	—	—	39
12	—	—	0	10kg/cm²	8	gradually	7	14	—	—	43
Comp. Ex. 3											
13	—	—	—	—	—	—	20	17	—	—	—

[Example 3]

The lignocellulosic material samples were compacted and sealed between hot platens. Heating was conducted by from hot platens and high-frequency electric heating by means of a compression device adapted to be capable of high-frequency heating. As the lignocellulosic material sample, several sugi lumber each having a moisture content of 20% and a size of 30 mm thick, 150 mm wide, and 600 mm long were prepared. Each sugi lumber was placed on the lower hot platen of the heat-compression device, and all around the sugi lumber is disposed an elastic silicone piece of 32 mm high and 30 mm wide as a sealing member, and all around the sealing member a stainless steel piece of 12 mm high and 50 mm wide was disposed as a thickness regulating jig.

The platens were maintained at 180 °C, and moved to be brought into contact with the lignocellulosic material, under this condition, the lignocellulosic material was heated for 2 min by the hot platens and high-frequency wave of 13.56 MHz, 200V and 8 kW output. Then the lignocellulosic material was compressed gradually to a compaction ratio of 60%. Heating was continued by hot platens and high-frequency waves for 4, 6, or 8 min, thus effecting permanent setting of compacted lignocellulosic material. The pressure of steam evolved from the lignocellulosic material and confined between the hot platens during the heating was kept at 10 kgf/cm^2 by means of a pressure regulating valve. After the the heating for the predetermined period of time, the pressurized steam was released gradually.

Each sample was examined for thickness swelling and recovery ratios in the edge and central portions in the same manner as in Example 1. the results are shown in Table 2, No. 1-3.

The time required for the entire procedure of treatment of each of sugi lumbers was determined for each group. The results are shown in Table 2, No.1-3.

The surfaces were very stiff, smooth and beautiful.

[Example 4]

The same sugi lumber was used and subjected to the same treatment as in Example 3, except that pressure release was conducted by causing cooling water to run through the hot platens to quickly bring the hot platens into a cold condition with a view to quenching the the lumber under treatment. For each sample, thickness swelling and recovery ratios in the edge and central portions were determined in the same manner as in Example 1. The results are shown in Table 2, No. 4-6.

The time required for the entire procedure of treatment per sugi lumber was also determined for each of the groups. The results are also shown in Table 2, No. 4-6.

The surfaces of the thus obtained products were very stiff, and smoother and more beautiful than those in Example 3.

[Comparative Example 4]

The same lumber as used in Example 3 was inserted between a pair of hot platens placed in a sealing pressure vessel and capable of effecting high-frequency electric heating. The lumber was heated for 2 min by a high-frequency wave of 13.56 MHz and 200V · 8kW output. Subsequently, the lumber was gradually compacted to 60% compaction ratio. Heating was continued using the same high-frequency wave for 4, 6, or 8 min to effect permanent setting of the compacted lignocellulosic material. The pressure between the hot platens was kept at 10 kgf/cm^2 by means of a pressure regulating valve. After the predetermined time of the heating, the steam in the vessel was gradually discharged to effect pressure release.

For each sample, thickness swelling and recovery ratios in the edge and central portions were determined in the same manner as in Example 1. Table 2, No. 7-9 show the results.

The time required for the entire procedure of treatment was measured for each group. The results are also shown in Table 2, No. 7-9.

By the treatment, the surfaces of the samples became stiff, but not as much as in Example 3. Also, the appearance was poor distinctly.

[Example 5]

Several pieces of white oak sapwood with a moisture content of 10%, 15 mm thick, 150 mm wide, and 600 mm long were prepared and divided into three groups. The same treatment as in Example 3 was applied to all groups, except that a stainless member of 15 mm high and 50 mm wide was placed as a thickness regulating jig, and that the first step including compaction was omitted. The thickness swelling ratio in the radial direction

was determined in the same manner as in Example 3. Table 2, No. 10-12 show the results.

As in Example 3, the time required for the entire procedure of treatment was also determined for each group. The results are shown in Table 2, No. 10-12.

The surfaces of the samples were very stiff, smooth and beautiful.

[Comparative Example 5]

White oak sapwood pieces of the same size as in Example 5 were divided into 3 groups. These were subjected to a high temperature, high-pressure steam treatment in an autoclave for 4, 6, 8 min while being restrained from undergoing deformation by means of stainless steel jigs. The pressure of the steam was 10 kgf/cm^2 and the temperature in the autoclave was maintained at 180 °C. For each group, the pressure in the autoclave was gradually released to obtain compacted lignocellulosic materials.

The thickness swelling ratio in the radial direction was determined for each group as in Example 5. Table 2, No. 13-15 show the results.

As in Example 5, the time required for the entire procedure of treatment was determined for each group. The results are also shown in Table 2, No. 13-15.

By the treatment, the surfaces of the samples became stiff, but not as much as in Example 5. Also, the appearance was poor distinctly.

[Comparative Example 6]

The same white oak sapwood pieces as used in Example 5, which were untreated, were boiled in a boiling bath for 2 hr. Then, for each of the resultants, thickness was measured and thickness swelling ratio in the radial direction was determined. Table 2, No.16 shows the results.

[Discussion on Table 2]

As evident from Table 2, most lignocellulosic materials subjected to the treatment according to the present invention were cases superior in radial thickness swelling and recovery ratios to those treated in an autoclave, thus showing improved dimensional stability. Significance of the present invention is evidenced by the improved thickness swelling ratio and recovery ratio in the central portions in all cases. Especially, the so-called hot-cold treatment was very effective.

The time for the treatment was also reduced, resulting in higher productivities.

Further, the surface finish was very beautiful in comparison to the other cases.

Tabl 2

	treatment		result				
	treating time	pressure release method	thickness swelling ratio		recovery ratio		treatment cycle
	time		edge	center	edge	center	
	min.	5min.	%	%	%	%	min.
Ex.3							
1	4	gradually	36	28	23	20	17
2	6	gradually	26	24	10	8	19
3	8	gradually	10	10	0	0	21
Ex.4							
4	4	cold	31	25	18	16	17
5	6	cold	23	20	8	5	19
6	8	cold	8	7	0	0	21
Comp. Ex.4							
7	4	gradually	31	80	13	43	39
8	6	gradually	21	48	6	35	41
9	8	gradually	10	32	0	24	43
Ex.5							
10	4	cold	12	10	-	-	15
11	6	cold	8	7	-	-	17
12	8	cold	5	5	-	-	19
Comp. Ex.5							
13	4	gradually	13	16	-	-	29
14	6	gradually	9	15	-	-	31
15	8	gradually	7	14	-	-	33
Comp. Ex.6							
16	-	-	20	17	-	-	-

[Example 6]

Several pieces of sugi each having a moisture content of 20% and a size of 30 mm thick, 150 mm wide, and 600 mm long were prepared and divided into four groups.

With respect to each group, each lumber was placed on the lower hot platen of a compression device equipped with hot platens capable of supplying a high-pressure steam from the platen surfaces. All around the sugi lumber was placed an elastic silicone member of 32 mm high and 30 mm wide placed as a sealing member, and all around the sealing member was placed stainless steel member of 12 mm high and 50 mm wide as a thickness regulating jig. The hot platens were set to be at 180 °C, and mov d to be brought in contact with the

sugi lumber. As a first step, a high-pressure steam having a pressure of 6 kgf/cm² and a temperature of 158 °C was injected from the platen surfaces for 4 min. At the final stage of the injection, the compression device was operated to bring the platens close until the movement was restricted by the thickness regulating jig, thereby compacting the sugi lumber to a compaction ratio of 60%.

Under this condition, a high-pressure steam of 10kgf/cm² and a temperature of at about 180 °C was injected from the surface of the hot platens for 4min as a second step, for each of Group 1 and Group 2. After termination of the supply of high-pressure steam, for Group 1, the pressure was gradually released over a period of 5 min. For Group 2, after termination of the supply of the high-pressure steam, the pressure was gradually released over a period of 5 min while supplying cooling water to the hot platens. For each of Groups 3 and 4, the same high-pressure steam was injected from the surfaces of the hot platens for 8 min. For Group 3, after termination of the supply of the high-pressure steam, the pressure was gradually released over a period of 5 min. For Group 4, after termination of the supply of the high-pressure steam, the pressure was gradually released over a period of 5 min while supplying cooling water to the hot platens.

The final products were boiled in a boiling bath for 2 hours and then dried. Each of the resultants was measured for thickness, and determined for thickness swelling and recovery ratios in the edge and central portions in the same manner as in Example 1. Table 1, No. 1-4 show the results.

The time required for the entire procedure of treatment per sugi lumber was determined for each group. The results are also shown in Table 3, No. 1-4.

The surface of the samples became very stiff, smooth, and beautiful.

[Comparative Example 7]

Sugi samples of the same size as in Example 1 were heat-softened by soaking in a hot water at 95 °C for 20 min (boiling treatment) as a first step, and then compacted to 60% compaction ratio by a heat compression device set to be at 105 °C. The sugi lumbers were divided into two groups, and were treated in an autoclave with hot, high-pressure steam for 4 min for Group1, and 8 min for Group 2, while being restrained from undergoing deformation by means of stainless steel jigs. The steam was 10 kgf/cm² and the temperature in the autoclave was 180 °C. The pressure in the autoclave was released gradually and two groups of treated lignocellulosic materials were obtained.

In the same manner as in Example 6, for each treated products, the thickness swelling ratio and recovery ratio in the radial direction were determined in edge portions and central portions. the results are shown in Table 3, No.5-6.

Similarly, the time required for the entire procedure of treatment per sugi lumber was determined for each group. The results are also shown in Table 3, No.5-6.

By the treatment, the surfaces of the samples became stiff, but not as much as in Example 6. Also, the appearance was poor distinctly.

[Example 7]

Several pieces of white oak sapwood each having a moisture content of 10% and a size of 15 mm thick, 150 mm wide, and 600 mm long were prepared and divided into four groups. The same treatment as in Example 1 was applied to all groups, except that a stainless steel member of 15 mm high and 50 mm wide was placed as a thickness regulating jig, and that the first step including compaction was omitted. The thickness swelling ratio in the radial direction was determined in the same manner as in Example 1. The results are shown in Table 3, No. 7-10.

The surfaces of the samples were very stiff, smooth, and beautiful as in Example 6.

[Comparative Example 8]

White oak sapwood pieces of the same size as in Example 7 were divided into 2 groups. The same treatment as in Comparative Example 7 was applied to these groups, except that boiling and compaction treatments were omitted and that a stainless steel member of 15 mm high and 50 mm wide was placed as a thickness regulating jig. The thickness swelling ratio in the radial direction and the treatment cycle were determined in same manner as before. Table 3, No. 11-12 show the results.

The surfaces of the samples were stiff but not as much as in Example 7. Also, the appearance was poor distinctly.

[Comparative Example 9]

White oak sapwood pieces same as used in Example 7, which were untreated, were boiled in a boiling bath for 2 hr and then their thicknesses were measured. The thickness swelling ratio in the radial direction and treatment cycle was determined. The results are shown in Table 3, No. 13.

[Example 8]

In this example, concurrent formaldehyde treatment was employed. Several white oak sapwood pieces same as used in Example 7 were prepared and divided into two groups. Each sample was placed on the lower hot platen of a compression device equipped with hot platens capable of supplying high-pressure steam from the platen surfaces. All around the white oak sapwood was placed an elastic silicone member of 32 mm high and 30 mm wide as a sealing member, and all around the sealing member was placed a stainless steel member of 15 mm high and 50 mm wide as a thickness regulating jig.

The hot platens were set to be at 180 °C, and then moved to be brought in contact with the white oak sapwood. At this point, 5 g of previously prepared formaldehyde vapor (volume conversion: 1 g/L) containing 2% (W/W) sulfur dioxide was injected, concurrently with high-pressure steam of 10 kgf/cm^2 and 158 °C, into the space between the hot platens. Injection was continued for 4 min for Group1 and 8 min for Group 2. After termination of the injection and attendant termination of the supply of high-pressure steam, the pressure was gradually released over a period of 5 min.

Each group was subjected to the same treatment as in the previous Examples and determined for thickness swelling in radial direction and treatment cycle. The results are shown in Table 3, No. 4-15.

[Discussion]

As is apparent from Table 3, the treatment according to the present invention comprises the injection of a high-pressure steam, which includes injection of a high-pressure steam containing a chemical agent, from the platen surfaces toward the lignocellulosic material, and accordingly, enables higher compaction ratio to be attained at the surface of the lignocellulosic material than in the inner portion, thereby enabling stiff and smooth surfaces to be obtained. In most cases, it is understood the thickness swelling ratio and recovery ratio in the radial direction were superior to those of the materials treated in an autoclave, thus giving improved dimensional stability. In all cases, the improved thickness swelling ratio and recovery ratio in the central portion were attained, evidencing superiority of the present invention. The effect is especially remarkable with samples subjected to the so-called "hot-cold" treatment.

The time required for the treatment was reduced, providing higher productivity.

The surface appearance of the treated products was very beautiful over the resultants in Comparative Examples.

Table 3

							result				
	first step (compaction)			second step		pressure release method	thickness swelling ratio		recovery ratio		treatment cycle
	steam	time	cpmpaction ratio	steam	time		edge	center	edge	center	
	kgf/cm²	min.	%	kgf/cm²	min.	5 min.	%	%	%	%	min.
Ex. 6											
1	6	4	60	10	4	gradually	35	53	23	35	19
2	6	4	60	10	4	cold	27	36	18	24	19
3	6	4	60	10	8	gradually	8	12	0	0	23
4	6	4	60	10	8	cold	3	6	0	0	23
Comp. Ex. 7											
5	boiling treatment		60	10	4	gradually	33	81	22	54	39
6	boiling treatment		60	10	8	gradually	8	36	0	24	43
Ex. 7											
7	—	—	0	10	4	gradually	14	16	—	—	15
8	—	—	0	10	4	cold	11	13	—	—	15
9	—	—	0	10	8	gradually	7	9	—	—	19
10	—	—	0	10	8	cold	3	6	—	—	18
Comp. Ex. 8											
11	—	—	0	10	4	gradually	14	18	—	—	39
12	—	—	0	10	8	gradually	7	14	—	—	43
Comp. Ex. 9											
13	—	—	—	—	—	—	20	17	—	—	—
Ex. 8											
14	—	—	0	10	4	cold	8	9	—	—	15
15	—	—	0	10	8	cold	3	3	—	—	14

[Example 9]

Several pieces of sugi each having a moisture content of 20% and size of 30 mm thick, 150 mm wide, and 600 mm long were prepared. Besides, using a stainless steel strip of 2 mm thick and 10 mm wide, frames for

compaction 10 as shown in Fig.1 were prepared in conformity with the contour of the lignocellulosic material.

Each lignocellulosic material, with the frames disposed on the lower and upper surfaces of the lignocellulosic material, was placed on the lower hot platen of a compression device equipped with hot platens capable of supplying a high-pressure from the platen surfaces. All around the lignocellulosic material with the frames, a stainless steel piece of 12 mm high and 50 mm wide was placed as a thickness regulating jig.

The hot platens were set to be at 180 °C and moved to be brought in contact with the lignocellulosic material. At this point, high-pressure steam of 10 kgf/cm² and 180 °C was injected from the platen surfaces for 2 min. Subsequently, the hot platens were gradually brought close until the movement was restricted by the thickness regulating jig. The sugi lumber was compressed to a compression ratio of 60%.

Under this condition, in parallel with the heating, injection of the high-pressure steam of 10 kgf/cm² and about 180 °C was continued for 4, 6, or 8 min. After the injection, the pressure was gradually released over a period of 5 min while supplying cooling water to the hot platens.

The final products after the pressure release were boiled in a boiling bath for 2 hours and completely dried. For each of the resultants, thickness was measured, and thickness swelling and recovery ratios in the edge and central portions were determined in the same manner as in Example 1. The results are shown in Table 4, No. 1-3.

The time required for the entire procedure of treatment per sample was determined for each group. The results are shown in Table 4, No. 1-3.

[Comparative Example 10]

The same lumbers as used in Example 9 were subjected to the same treatment and the same measurement in the same manner as in Example 9, except for that no frames 10 for compaction were used and that all around the sugi lumber was placed an elastic silicone member of 32 mm high and 30 mm wide as a sealing material. The results are shown in Table 4, No. 4-6.

[Example 10]

The same sugi lumbers as used in Example 9 were used, and the same compression frame and thickness control jig as used in Example 9 were prepared. The lignocellulosic material, with the frames disposed on the upper and lower surfaces of the lignocellulosic material, was placed between hot platens of a compression device capable of performing high-frequency electric heating. The lignocellulosic material was heated for 2 min by a high-frequency wave of 13.56 MHz and 200 V · 8 kW output. Subsequently, the lignocellulosic material was compressed gradually to a compaction ratio of 60%. Heating was continued using the same high-frequency waves for 4, 6, or 8 min. The pressure was gradually released over a period of 5 min while supplying cooling water to the hot platens in each case.

After the pressure release, for each resulting sugi lumber, the same measurements as in Example 9 were conducted. The results are shown in Table 4, No. 7-9.

[Comparative Example 11]

The same lumbers as used in Example 9 were subjected to the same treatment and the same measurement in the same manner as in Example 10, except for that no frames 10 for compaction were used and that all around the sugi lumber was placed an elastic silicone member of 32 mm high and 30 mm wide as a sealing material. The results are shown in Table 4,no. 10-12.

[Discussion]

As is understood from Table 4, Examples 9 and 10 gave lignocellulosic material products having properties substantially comparable to those in Comparative Examples 10 and 11. This means that, without using a silicone packing which is expensive and inevitably required to be replaced, it is possible to obtain treated lignocellulosic materials having properties substantially comparable to those prepared using a silicone packing. This enables cumbersomeness due to the use of such an awkward sealing member as a silicone packing to be eliminated and cost reduction to be realized. In particular, use of frames made of a stainless steel yields greatly enhanced economical effects because they can be used semi-permanently.

Table 4

	treatment		result				
	treating time	pressure release method	thickness swelling ratio		recovery ratio		treatment cycle
	time		edge	center	edge	center	
	min.	5min.	%	%	%	%	min.
Ex. 9							
1	4	cold	24	34	15	21	17
2	6	cold	18	19	9	10	19
3	8	cold	3	5	0	0	21
Comp. Ex. 10							
4	4	cold	25	33	16	21	17
5	6	cold	18	20	9	11	19
6	8	cold	3	5	0	0	21
Ex. 10							
7	4	cold	35	29	22	20	17
8	6	cold	24	24	9	8	19
9	8	cold	9	9	0	0	21
Comp. Ex. 11							
10	4	gradually	36	28	23	20	17
11	6	gradually	26	24	10	8	19
12	8	gradually	10	10	0	0	21

[Example 11]

As lignocellulosic material samples, several pieces of sugi each having a moisture content of 20% and size of 30 mm thick, 150 mm wide, and 600 mm long were prepared. Each of the samples was placed in a rigid stainless steel vessel as shown in Figs. 3 and 4, and subjected to compression and heating. The the inner space formed in the vessel body 21 of the stainless steel vessel 20 had such dimensions that height H = 12 mm, width X = 160 mm, and length L = 610 mm. As the lid 22, a stainless steel plate of 10mm thick was used. To the top edge of the vessel body 20, a heat-resistant elastic silicone packing 23 was attached all along the upper edge.

Th vessel containing the sugi lumber and the lid placed thereon were placed on the lower hot platen of a compression device. The hot platens were set to be at 200 °C, and then moved to cause the lid 22 to contact with upper edge of the vessel body under pressure of 50 kgf/cm^2. Under this condition, the heating was continued 5 or 10 min. Subsequently, the pressure was released over a period of 5 min while supplying cooling water to the hot platens. Then, the rigid vessel was removed from between the hot platens to obtain a compacted lignocellulosic material. The sugi lumber with an initial thickness of 30 mm was compressed to a thickness of 12 mm (compression ratio, 60%).

[Example 12]

THe same material as used in Example 11 was used, and a hot press equipped with hot platens capable of performing high-frequency electric heating was used in this Example. The rigid vessel composed of vessel body made of a stainless steel and a lid made of a polycarbonate was used. The hot platens were set to be at 180 °C, and moved to cause the lid 22 to contact with the upper edge of the vessel body 21 under pressure of 50 kgf/cm^2. Under this condition, the sample was irradiated with a high-frequency wave of 13.56 MHz and 200 V · 8 kW output for 2 or 4 min. Subsequently, the pressure was released over a period of 5 min while supplying cooling water to the hot platens. The rigid vessel was removed from between the hot platens to obtain a compacted lignocellulosic material. The sugi lumber with an initial thickness of 30 mm was compressed to a thickness of 12 mm (compression ratio, 60%).

[Example 13]

The same treatment as in Example 12 was conducted, except that a 0.2 mm PET sheet was laid over the surface of the lignocellulosic material sample prior to the placement of the polycarbonate lid and then compression and heating were conducted.

[Example 14]

The same treatment as in Example 12 was conducted, except that the inner bottom of the rigid vessel body was covered with a 0.4 mm silicone rubber sheet and the lignocellulosic material was placed thereon, and that the same silicone rubber sheet was laid over the surface of the lignocellulosic material so as to entirely cover the open side of the vessel body prior to the placement of the lid and then the lid was placed thereon, followed by compression and heating.

[Comparative Example 12]

The same material as used in Examples 11 and 12 was used. The sugi lumber was placed on the lower hot platen of a compression device, and all around the sugi lumber was placed an elastic silicone member of 32 mm high and 30 mm wide was placed as a sealing member, and all around the sealing member was placed a stainless steel member of 12 mm high and 50 mm wide as a thickness regulating jig. The hot platens were set to be at 200 °C, and moved under pressure of 50 kgf/cm^2 until the movement of the hot platen is restricted by the thickness regulating jig, thereby compressing the lignocellulosic material.

Under this condition, the heating was continued for 10 or 20 min. Then, the pressure was released over a period of 5 min while supplying cooling water to the hot platens. The vessel was removed from between the hot platens to obtain a compressed lignocellulosic material. The compressed sugi lumber, with an original thickness of 30mm, was compressed to a thickness of 12mm (compression ratio, 60%).

The thus obtained final products were each boiled in a boiling bath for 2 hours and completely dried. The resultants were each measured for thickness, and determined for thickness swelling and recovery ratios in the edge and central portions. Table 5 shows the results.

Recovery ratio = (thickness after 2 hr boiling and complete drying - thickness after compaction)/(thickness before compaction - thickness after compaction) x 100 %

[Discussion]

It is evident from Table 5 that, according to the method for stabilizing a lignocellulosic material of this embodiment, the compacted lignocellulosic materials with smaller recovery ratio were obtained in a shortened treating time (heating time). Further, the lignocellulosic material to be used is placed in the rigid vessel and then the lignocellulosic material-containing rigid vessel is placed on the hot platen, without the placement of

thickn ss regulating jig on the hot platen, and the compacted lignocellulosic material was taken out subsequently to the treatment. Accordingly, procedure for the treatment can be simplified. Further, in all cases, no deformation or breakage of silicone packing was observed. The treatment was completely and uniformly effected throughout the sample, even in the core portion thereof, for all cases. Moreover, in Example 13, removal of the lid was facilitated and clearly enhanced surface gloss was attained by virtue of the PET sheet laid over the surface of the lignocellulosic material. Furthermore, in Example 14, fine irregularities were formed on the surface which had contacted with the silicone rubber sheet, thereby enabling a compacted product having a highly realistic "wooden" texture and high aesthetic value to be obtained.

Table 5

	heating time		recovery ratio		surface condition
	temperature °C	time min.	edge %	center %	
Ex. 11	200	5 10	5 0	5 0	smooth, somewhat glossy
Ex. 12	180 + h.f.wave	2 4	5 0	4 0	smooth, somewhat glossy
Ex. 13	180 + h.f.wave	2 4	5 0	4 0	smooth, glossy
Ex. 14	180 + h.f.wave	2 4	4 0	3 0	fine irregularities were formed on the surface which had been in contact with silicone rubber sheet, somewhat glossy
Comp. Ex. 12	200	10 20	17 0	18 0	smooth, somewhat glossy

[Example 15]

As lignocellulosic material samples, sugi lumbers each having a moisture content of 20% and size of 30 mm thick, 150 mm wide, and 600 mm long were prepared. On the lower hot platen 1a of a compression device equipped with hot platens each having a mirror-like surface, which is of the type as described in Fig.6, a silicone rubber sheet S was laid, and the sugi lumber W was placed thereon. All around the sugi lumber was placed an elastic silicone rubber member of 32 mm high and 30 mm wide as a sealing member 2, and all around the sealing member was placed a stainless steel rod of 12 mm high and 50 mm wide as a thickness regulating jig 3. Further, a silicone sheet S' of 0.4mm thick was laid thereon to entirely cover the sugi lumber, sealing member and thickness regulating jig.

The hot platens 1a,1b were set to be at 200 °C and then moved to be brought in contact with the sugi lumber via silicone rubber sheets S,S' under pressure of 50 kgf/cm^2, and first heating was conducted for several minutes. Thereafter, the compression device was operated to bring the hot platens close until the movement of the hot platen 1b was restricted by the thickness regulating jig 3, thereby gradually compacting the lignocellulosic material W. The sugi lumber was thus compressed to a compression ratio of about 60%. Under this condition, the heating was continued for 5 min or 10 min. Then, the pressure was released over a period of 5 min while supplying cooling water to the hot platens 1a,1b. From between the hot platens, a compacted lignocellulosic materialwas taken out.

[Example 16]

Using the same sugi lumbers and silicone rubber sheets as used in Example 15, compaction was conducted. In this example, a press equipped with hot platens capable of applying a high-frequency wave. The lignocellulosic material and the other members are arranged in the same manner as in Example 15. Then, the hot platens were set to be at 180 °C and moved to bring the hot platen in contact with the sugi lumber via the upper silicone rubber sheet under pressure of 50 kgf/cm^2 to contact the sugi sample via the silicone rubber sheet covering the same. Primary heating was conducted for several minutes, and then the compression device was operated until the platen was restricted the thickness regulating jig. Under this condition, the sugi lumber was irradiated with a high-frequency wave of 13.56 MHz and 200 V · 8kW output for 2 min or 4 min. Then, the pressure was released over a period of 5 min while supplying cooling water to the hot platens. From between the hot platens, a compacted lignocellulosic material was taken out.

[Example 17]

The same treatment as in Example 16 was conducted, except that the sugi lumber was placed directly on the lower hot platen without a sheet material. The sugi lumber, the sealing member and the thickness regulating jig were entirely covered with a 0.2mm thick PET sheet having its surface embossed, followed by compression and heating.

[Comparative Example 13]

The same sugi lumbers as in Example 15 were used, and compaction was conducted under the same conditions as in Example 15 except that no sheet members were used.

The thus obtained final products in Examples and Comparative Examples were each boiled for 2 h in a boiling bath and then dried completely. For each resultant, thickness was measured, and thickness recovery ratio in the radial direction in edge and central portions were determined in accordance with the following equation. Table 6 shows the results and the surface characteristics.

Recovery ratio = (thickness after 2 hr boiling and complete drying - thickness after compaction)/(thickness before compaction - thickness after compaction) x 100 %

[Discussion]

As is evident from Table 6, according to the process for stabilizing a lignocellulosic material of this embodiment, although the lignocellulosic material was held and compacted between the mirror-finished hot platens, fine irregularities were formed on the surface of the lignocellulosic material, thereby enabling the product having a highly realistic wood texture and high aesthetic value. The recovery ratio was remarkably improved by the improved sealing condition due to the use of the sheet members.

In particular, the elastic silicone packings in Examples 15 and 16 underwent smaller deformation as com-

pared with those in Example 17 or Comparative Example 13. Also, in Examples 15 and 16, he treatment was uniformly and completely effected throughout the sample, even in the core portion. This is considered to be attributable to the result of the further improved sealed condition by the use of silicone rubber sheets as sealing members. En Example 17, the presence of the PET sheet laid over the sample surface particularly facilitated removal of the sample from the hot platen, thus enabling satisfactory operational facility to be attained.

Table 6

	heating time		recovery ratio		surface condition
	temperature °C	time min.	edge %	center %	
Ex. 15	200	5 10	4 0	4 0	fine irregularities were formed on the surface which had been in contact with silicone rubber sheet, somewhat glossy
Ex. 16	180 + h.f. wave	2 4	4 0	4 0	fine irregularities were formed on the surface which had been in contact with silicone rubber sheet, somewhat glossy
Ex. 17	180 + h.f. wave	2 4	5 0	5 0	fine irregularities were formed on the surface which had been in contact with PET sheet, somewhat glossy
Comp. Ex. 13	200	10 20	17 0	18 0	smooth, somewhat glossy

[Example 18]

As a lignocellulosic material sample, a sugi veneer with a moisture content of 20%, 2mm thick, 303mm wide, and 303mm long was prepared. On the lower hot platen 1a of a compression device having hot platens with mirror-like surfaces and of a typ as described with reference to Fig.6, a non-woven fabric S of 0.2mm

thick and $50g/m^2$ was laid and the abov -mentioned sugi veneer W placed thereon. Further, all around the sugi veneer was placed an elastic silicone piece of 4mm high and 10mm wide as a sealing member 2, and all around the sealing member 2 was placed a stainless steel piece of 1mm thick and 10mm wide as a thickness regulating jig 3, and over the sugi veneer, the sealing member and the thickness regulating jig was placed the same non-woven fabric S' as above.

The hot platens 1a,1b were set to be at 180 °C, then moved to be brought into contact with the sugi veneer via the non-woven fabrics S,S' under pressure of $50kgf/cm^2$, thereby effecting a primary heating for several min. Then the compression device was operated to bring the hot platens close until the movement of the hot platen 1b was restricted by the thickness regulating jig 3, thus gradually compacting the lignocellulosic material W. The sugi veneer was thereby compacted to a compaction ratio of about 50%. Under this condition, heating was continued for 15 min. Then, cooling water was supplied to the hot platens 1a,1b for 15 minutes, followed by pressure release. The compacted lignocellulosic material between the hot platens was taken out, and the non-woven fabrics were removed.

The removal was easy, the surfaces of the lignocellulosic material were not stained with a resinous substance and were beautiful.

[Example 19]

The same treatment was conducted as in Example 18, except that a Japanese paper of 0.1mm thick and $15g/m^2$ whose surfaces were coated with silicone was used as an absorptive sheet S and the same Japanese paper but not silicone-coated was used as an absorptive sheet S'. The compacted lignocellulosic material was taken out, and the absorptive sheets S,S' were removed. The absorptive sheet S was easily removed, and the surface of the lignocellulosic material was not stained with a resinous substance and beautiful. On the other hand, the absorptive sheet S' adhered to the surface of the lignocellulosic material due to a substance oozed from the the lignocellulosic material by the compaction, and cannot be removed.

[Comparative Example 14]

By using the same sugi veneer as in Example 18, several veneers were subjected to compaction under the same conditions as in Example 18 except that no sheet was used.

The surfaces of the veneers were examined. With respect to some of them, stains due to a resinous substance were observed on their surfaces.

[Example 20]

Treatment was conducted in the same manner as in Example 19 except that the same absorptive sheets S,S' as in Example 19 which comprises a Japanese paper as a base material were impregnated with water in an amount of about $1g/m^2$, $2g/m^2$, or $3g/m^2$ and then used. After the compaction, only one absorptive sheet S was removed from each of the compacted lignocellulosic material, and each of them was boiled in a boiling bath for 2 hours and then completely dried. The thickness of the each resultant was measured, and the recovery ratio in the radial direction was determined in an edge portion and a central portion in accordance with the following formula. Besides, the compacted lignocellulosic materials in Example 19 (,namely, those compacted using sheets S,S impregnated with no water) were subjected to the same treatment. The results are shown in Table 7.

Recovery ratio = (thickness after 2hr boiling followed by complete drying - thickness after compaction)/(thickness before compaction - thickness after compaction)x100%

It is understood from Table 7 that when the treatment is conducted with sheets impregnated with water, improved dimensional stability is attained.

Table 7

Example 20		
amount of water impregnated into each sheet S, S' (g/m^2)	revocery ratio (%)	moisture content of lignepous material after compaction treatment (%)
0 (Ex. 19)	25	8
about 1	19	15
about 2	16	20
about 3	10	25

[Example 21]

As a lignocellulosic material sample, a sugi lumber with a moisture content of 20%, 30mm thick, 150mm wide, and 600mm long was prepared. On the lower hot platen 1a of a compression device having hot platens with mirror-like surfaces and of a type as described with reference to Fig.8, a silicone rubber sheet S of 0.4mm thick, 220mm wide and 670mm length was laid, and thereon was placed a quardrangle-like thickness regulating jig 3 as shown in Fig.9 which was made of a stainless steel plate and which was of 12mm high, 210mm wide and 660mm long and through which a rectangular center opening of 170mm wide and 600mm long was formed. In the above-mentioned opening, the above-prepared sugi lumber was placed. Over the sugi lumber and the thickness regulating jig was placed a silicone rubber sheet S' having the same thickness of 0.4mm as that of the silicone rubber sheet S laid below.

The hot platens 1a,1b were set to be at 200 °C, then moved to be brought into contact with the sugi lumber via the silicone rubber sheets S,S' under pressure of 50kgf/cm^2, thereby effecting a primary heating for several min. Then the compression device was operated to bring the hot platens close until the movement of the hot platen 1b was restricted by the thickness regulating jig 3, thus gradually compacting the lignocellulosic material W. The sugi veneer was thereby compacted to a compaction ratio of about 60%. Under this condition, heating was continued for 5 or 10 min. Then, cooling water was supplied to the hot platens 1a, 1b for 5 minutes, followed by pressure release. The compacted lignocellulosic material between the hot platens was taken out.

[Example 22]

As a thickness regulating jig, a box-like jig prepared by welding a stainless steel plate of 6mm thick as a bottom plate to the same thickness regulating jig as in Example 21 was used. The box-like thickness regulating jig is placed on the lower hot platen. On the entire inner bottom surface of the box-like thickness regulating jig was laid the same silicone rubber sheet as used in Example 1, and then the same sugi lumber was placed in the cavity. Then, the same treatment as in Example 21 was conducted.

[Example 23]

As a lignocellulosic material sample, a sugi lumber with a moisture content of 20%, 30mm thick, 150mm wide, and 600mm long was prepared. As a thickness regulating jig, one obtained by using a polycarbonate resin instead of a stainless steel as a material and forming it into the same dimensions as in Example 21 was used. In the same manner as in Example 21, a silicone rubber sheet, the thickness regulating jig, and the sugi lumber were arranged between hot platens, and then compaction was conducted. However, a compression press having hot platens capable of applying high-frequency was used in this Example. The hot platens were set to be at 180 °C, then moved to be brought into contact with the sugi lumber via a silicone rubber sheet being laid over the lumber in the same manner as in Example 21 under pressure of 50kgf/cm^2, thereby effecting a primary heating for several min. Then, the compression device was operated to bring the hot platens close until the movement of the hot platen was restricted by the thickness regulating jig, thus gradually compacting the lignocellulosic material W. Under this condition, heating was conducted first for 5 or 10 min by hot platens(200 °C, 50kg/cm^2) and next for 2 or 4 min by irradiation with a high-frequency wave of 13.56MHz and 200V·8kW output, respectively. Then, cooling water was supplied to the hot platens for 5 minutes, followed by pressure release. The compacted lignocellulosic material between the hot platens was taken out.

[Comparative Example 15]

By using the same sugi lumber as in Example 21, compaction was conducted under the same conditions as in Example 21 except that no sheet was used.

[Comparative Example 16]

Treatment was conducted in the same manner as in Example 21 except that a thickness regulating jig having a larger opening was used and a sealing member made of an elastic silicone rubber of 32mm high and 10mm wide was disposed between the sugi lumber and the inner surface of the thickness regulating jig.

Each of the final products obtained in Examples 21 to 23 and Comparative Examples 15 and 16 was boiled in a boiling bath for 2hr and then completely dried. The thickness of the each resultant was measured, and the recovery ratio in the radial direction was determined in an edge portion and a central portion in accordance with the following formula. The results are shown in Table 8.

Recovery ratio = (thickness after 2hr boiling followed by complete drying - thickness after compaction)/(thickness before compaction - thickness after compaction)x100%

[Discussion]

As is apparent from Table 8, sufficient compaction cannot be attained by using only a thickness regulating jig, whereas a satisfactorily compacted lignocellulosic material can be obtained by disposing sheets between a rigid thickness regulating jig and hot platens. It is also understood that compacted lignocellulosic materials having substantially the same recovery ratio were obtained as compared with those obtained by disposing the sealing material(s) according to the foregoing Examples.

Table 8

	heating time		recovery ratio	
	temperature °C	time min.	edge %	center %
Ex. 21	200	5	4.5	4.5
		10	0.0	0.0
Ex. 22	200	5	4.0	4.0
		10	0.0	0.0
Ex. 23	200	5+2	3.0	3.0
	+ h. f. wave	10+4	0.0	0.0
Comp. Ex. 15	200	5	19.0	21.0
		10	3.0	3.0
Comp. Ex. 16	200	5	4.4	4.4
		10	0.0	0.0

Next, with respect to lignocellulosic material specimens made of the same material, compacted lignocellulosic materials prepared by the process for preparing a compacted lignocellulosic material according to the eighth embodiment described with reference to Figs.10 to 14 [Examples] will be described in comparison with compacted lignocellulosic materials prepared by the above-mentioned processes for stabilizing a lignocellulosic material according to the first and second embodiments which are basically carried out batchwise, i.e., the process in which a lignocellulosic material, and around the lignocellulosic material, a resilient sealing means and (a) thickness regulating jig(s) are arranged between hot platens, and the lignocellulosic material is compacted by the hot platens, if desired, while supplying high-pressure steam from the surface of the hot platens toward the lignocellulosic material [Reference Example].

[Reference Example 17]

A lignocellulosic material sample was compacted and sealed between hot platens of a hot platen-equipped compression device and heated by the hot platens. As the lignocellulosic material sample, a sugi lumber with a moisture content of 20%, 30mm thick, 150mm wide, and 1000mm long was used.

The sugi lumber was placed on the lower hot platen of the compression device, and an elastic silicone member of 32mm high and 30mm wide as a sealing means was disposed all around the sugi lumber, and a stainless steel member of 12mm high and 50mm wide as a thickness regulating jig was disposed all around the sealing means. The hot platens were set to be at 200 °C, then moved to gradually compress the sugi lumber under pressure of 50kgf/cm^2, and the compression was continued until the movement of the hot platen was restricted by the thickness regulating jig. The sugi lumber was thereby compacted to a compaction ratio of about 60%.

This condition was maintained for such a period of time that the total of heat-compression time was 10min or 20min. Then, cooling water was supplied to the hot platens in each case, and 5min later, pressure release was gradually conducted.

[Reference Example 18]

As a compression device having hot platens, one capable of applying high-frequency wave and of supplying pressurized steam from the surfaces of the hot platens was used. The same lignocellulosic material sample as in Reference Example 17 was placed between the hot platens in the same arrangement as in Reference Example 17 and compressed. In the compression, the hot platens were set to be at 180 °C and pressure for the compression was 50kgf/cm^2. Application of high-frequency wave was commenced simultaneously with the commencement of the heat-compression and conducted using a high-frequency wave of 13.56MHz and 200V · 8kW output. Further, steam of 180 °C was injected under pressure of 10kgf/cm^2 during the heat-compression.

This condition was maintained for such a period of time that the total of heat-compression time and the high-frequency application time was 10min or 20min. Then, cooling water was supplied to the hot platens in each case, and 5min later, pressure release was gradually conducted.

[Example 24]

Using a device for stabilizing treatment of a belting press type as shown in Fig.10, a compacted lignocellulosic material was prepared from the same lignocellulosic material sample as in Reference Example 17. An upper endless belt 110 and a lower endless belt 120 of the stabilizing device were each made of a stainless steel of 2.0mm thick and perforated with no through-holes. The upper endless belt 110 had a center distance of 10m, and the lower endless belt 120 had a center distance of 12m. Onto the lower endless belt 120, elastic silicone members of 32mm high and 30mm wide were fixed as sealing means 123,124 by an adhesive, and stainless steel members of 12mm high and 50mm wide as thickness regulating jigs 125 were disposed outside the sealing means 123. The stainless steel jig was slitted at predetermined intervals.

Upstream three press rolls of four press rolls 133 were each equipped with built-in electric heaters 134a and controlled to maintain high temperature condition at 200 °C. The most downstream press roll was equipped with a circulation path 134b for cooling water and controlled to maintain low temperature condition at 20 °C.

Each of the press rolls 133 was controlled to exert compression pressure of 30kgf/cm^2, and the endless belts were controlled at such a traveling speed that time for heating by the press rolls 133 was 10min or 20min (,and actually, the traveling speed of the endless belts was 1.0m/min for the heating of 10min, and 0.5m for the heating of 20min).

Upon measurement of the surface temperature of lignocellulosic material by means of a thermocouple, it was 180 °C, 190 °C at the time when transmitted past the third press roll and was 90 °C, 60 °C at the time when transmitted past the most downstream press roll, respectively.

[Example 25]

Using a device for stabilizing treatment of a belting press type as shown in Fig.13, a compacted lignocellulosic material was prepared from the same lignocellulosic material sample as in Reference Example 17. An upper endless belt 110 and a lower endless belt 120 were each made of a stainless steel of 2.0mm thick and perforated with no through-holes. The upper endless belt 110 had a center distance of 7.5m, and therein, four press rolls were disposed. As in Example 24, upstream three press rolls of the four press rolls were controlled to maintain temperature condition at 200 °C, and the most downstream press roll was controlled to maintain

temperature condition at 20 °C. Further, hot rolls 170 were also located on the reverse side of the lower endless belt 120 oppositely to the upper hot rolls 170 to effect preliminary compression and preliminary heating of the lignocellulosic material. Each of the hot rolls 170 was 300mm in diameter and made of a hard chrome plated steel. The pairs of the hot rolls were each set to exert pressure of 100kgf/cm², and respectively set to be at 200 °C, 220 °C and 240 °C from the upper course to the lower course.

Each of the press rolls 133 was controlled to exert compression pressure of 5kgf/cm², and the endless belts were controlled at such a traveling speed that time for heating by the press rolls 133 was 5min or 15min (,and actually, the traveling speed of the endless belts was 1.0m/min for the heating of 5min, and 0.5m for the heating of 15min).

Upon measurement of the surface temperature of lignocellulosic material in the same manner, it was 160 °C, 180 °C just before brought into contact with the upper endless belt 110, was 180 °C, 190 °C at the time when transmitted past the third press roll, and was 90 °C, 60 °C at the time when transmitted past the most downstream press roll, respectively.

[Example 26]

Using a device for stabilizing treatment of a belting press type as shown in Fig.10, a compacted lignocellulosic material was prepared from the same lignocellulosic material sample as in Reference Example 17. An upper endless belt 110 and a lower endless belt 120 were each made of a stainless steel of 2.0mm thick and perforated with a large number of through-holes. The upper endless belt 110 had a center distance of 5m, and therein, four press rolls were disposed. Upstream two press rolls of the four press rolls were controlled to maintain temperature condition at 200 °C, and the downstream two press roll were controlled to maintain temperature condition at 20 °C. In the vicinities of the upstream two press rolls, electrodes capable of applying high-frequency wave were provided, and therefrom, high-frequency wave of 13.56MHz and 200V · 8kW output was applied. In addition, from steam injection nozzles 135 located in the vicinities of the press rolls 133, pressurized steam of 180 °C and 10kgf/cm². Each of the press rolls 133 was controlled to exert compression pressure of 50kgf/cm², and the endless belts were controlled at such a traveling speed that time for heating by the press rolls was 5min or 10min (,and actually, the traveling speed of the endless belts was 1.0m/min for the heating of 5min, and 0.5m for the heating of 10min).

Upon measurement of the surface temperature of lignocellulosic material in the same manner, it was 180 °C, 180 °C at the time when transmitted past the third press roll, and was 50 °C, 40 °C at the time when transmitted past the most downstream press roll, respectively.

With respect to Reference Examples 17, 18 and Examples 24, 25 and 26, treatment cycle per lignocellulosic material sample was measured. Further, each of the final products obtained was boiled in a boiling bath for 2hr and then completely dried. The thickness of the each resultant was measured, and the recovery ratio in the radial direction was determined in an edge portion and a central portion in accordance with the following formula.

Recovery ratio = (thickness after 2hr boiling followed by complete drying - thickness after compaction)/(thickness before compaction - thickness after compaction)x100%

The results are shown in Table 9 together with compression pressure, heating temperature, heating time and the like.

[Discussion]

As is apparent from Table 9, by virtue of the processes for preparing a compacted lignocellulosic material according to this embodiment, greatly shortened production cycles were attained, which are 1/15 to 1/20 as compared with those in the cases where the production was conducted using a compression device with hot platens, thereby enabling extremely improved productivity to be realized. It is also understood that excellent recovery ratios were attained, leading to improved dimensional stability. It should be noted that particularly excellent recovery ratios were attained when so-called "hot-cold" treatment wherein cold treatment was effected at a temperature of 80^A^N or lower was conducted. Further, particularly improved surface smoothness was attained in Example 26, although this is not shown in Table 9. This is believed to be attributable to the lower temperature of the cold treatment in Example 26 as compared with Examples 24 and 25.

Table 9

	pressure	heating		traveling speed of endless belt	production cycle	recovery tario	
		temperature	time			edge	center
	(kgf/cm^2)	(℃)	(min)	(m/min)	(min/piece)	(%)	(%)
Ref. Ex. 17	50 50	200 200	10 20	— —	20 30	19 0	18 0
Ex. 24	30 30	200 200	(10) (20)	1.0 0.5	1 2	15 0	14 0
Ex. 25 (hot roll) (hot roll) (hot roll) (hot roll) (hot roll) (hot roll)	100 100 100 5 100 100 100 5	240 220 200 200 240 220 200 200	— — — (5) — — — (15)	1.0 1.0 1.0 1.0 0.5 0.5 0.5 0.5	1 2	14 0	14 0
Ref. Ex. 18	50 50	pressurized steam 180℃($10kgf/cm^2$), ‡ h.f.wave, and hot platens 180℃	5 10	— —	15 20	18 0	16 0
Ex. 26	50 50	pressurized steam 180℃($10kgf/cm^2$), ‡ h.f.wave, and hot platens 180℃	(5) (10)	1.0 0.5	1 2	10 0	11 0

(‡ h.f.wave: high-frequency wave of 13.56MHz and 200V·8kW output)

Claims

1. A process for stabilizing a lignocellulosic material which comprises:
   holding a lignocellulosic material between one or more hot platens in a sealed condition, and
   heating the lignocellulosic material to vaporize moisture contained in the lignocellulosic material per se; thereby effecting high-pressure steam treatment of the lignocellulosic material.

2. The process for stabilizing a lignocellulosic material according to claim 1, wherein the lignocellulosic material is held between the hot platens with a sealing member.

3. The process for stabilizing a lignocellulosic material according to claim 1 or 2, wherein the lignocellulosic material is held between the hot platens in a compressed condition.

4. The process for stabilizing a lignocellulosic material according to any one of the preceding claims wherein the lignocellulosic material is heated while held between the hot platens.

5. The process for stabilizing a lignocellulosic material according to claim 4, wherein the heating is effected by hot platens and/or a high-frequency wave.

6. The process for stabilizing a lignocellulosic material according to any one of the preceding claims, further comprising supplying a high-pressure steam from the surfaces of the hot platens toward the lignocellulosic material.

7. The process for stabilizing a lignocellulosic material according to any one of the preceding claims, further comprising supplying a chemical agent for chemical treatment and/or for plasticization from the surfaces of the hot platens toward the lignocellulosic material.

8. The process for stabilizing a lignocellulosic material according to any one of the preceding claims is held between the hot platens with a thickness regulating jig arranged around the lignocellulosic material.

9. The process for stabilizing a lignocellulosic material according to claim 8, wherein the thickness regulating jig has a predetermined thickness and/or a requisite rigidity and/or a requisite heat resistance.

10. The process for stabilizing a lignocellulosic material according to claim 8 or 9, wherein the lignocellulosic material, frames respectively to be interposed between the lignocellulosic material and the hot platens and each capable or compressing a peripheral portion of the lignocellulosic material, the thickness regulating jig to be located around said lignocellulosic material for regulating movement of the hot platens are arranged between the hot platens, and the hot platens are moved to cause said frames to compress the peripheral portions of the lignocellulosic material, and under this condition, the lignocellulosic material is heated.

11. The process for stabilizing a lignocellulosic material according to any one of the preceding claims, wherein the lignocellulosic material to be treated is placed in an openable rigid vessel having pressure resistance and heat resistance, and then the rigid vessel is placed between the hot platens and brought to a sealed condition, and the lignocellulosic material is heated.

12. The process for stabilizing a lignocellulosic material according to claim 11, wherein the lignocellulosic material is placed in a rigid vessel via a sheet member, and then the rigid vessel is placed between the hot platens and brought to a sealed condition, and the lignocellulosic material is heated.

13. The process for stabilizing a lignocellulosic material according to any one of the preceding claims, wherein a sheet member or sheet members are interposed between the surface or surfaces of the lignocellulosic material and the or each hot platen, and under this condition, said lignocellulosic material is heated by the hot platen(s).

14. The process for stabilizing a lignocellulosic material according to claim 12 or 13, wherein the sheet member is a silicone rubber sheet.

15. The process for stabilizing a lignocellulosic material according to claim 12 or 13, wherein the sheet member is an absorptive sheet.

16. The process for stabilizing a lignocellulosic material according to claim 15, wherein the absorptive sheet is a member selected from the group consisting of a paper, a woven fabric and a non-woven fabric.

17. The process for stabilizing a lignocellulosic material according to claim 15 or 16, wherein the absorptive sheet or sheets are impregnated with water and then interposed between the surface or surfaces of the lignocellulosic material and the hot platen or hot platens.

18. The process for stabilizing a lignocellulosic material according to claim 12 or 13, wherein the sheet member is a sheet coated with a substance having release properties.

19. The process for stabilizing a lignocellulosic material according to any one of the preceding claims, wherein between endless belts adapted to have at least in part an opposed zone and to be such that the opposed surfaces travel in the same direction, which function as a pair of hot platens, the lignocellulosic material is fed with a resilient sealing member and a thickness regulating jig, if provided, disposed around the lignocellulosic material, and said lignocellulosic material is heated in the course of being caused to pass through said opposed zone between the endless belts.

20. The process for stabilizing a lignocellulosic material according to claim 19, wherein said resilient sealing member and said optional thickness regulating gig are mounted on the carrying surface of one of said pair of hot platens, and the lignocellulosic material is placed in the space defined by said means mounted on the carrying surface and then transmitted to said opposed zone between the pair of hot platens.

21. The process for stabilizing a lignocellulosic material according to claim 19 or 20, wherein a set of substrate and, disposed thereon, the lignocellulosic material with the resilient sealing member and, if desired, the thickness regulating jig disposed around the lignocellulosic material is separately prepared, and the set is fed to said opposed zone between the pair of endless belts.

22. The process for stabilizing a lignocellulosic material according to claim 19, 20 or 21, further comprising a step of preliminarily compressing said lignocellulosic material by one or more hot rolls as a pre-step prior to the passage of the lignocellulosic material through said opposed zone between the pair of endless belts.

23. The process for stabilizing a lignocellulosic material according to any one of claims 19 to 22, further comprising a step for supplying a high-pressure steam toward said lignocellulosic material during the passage of the lignocellulosic material through said opposed zone between the pair of endless belts.

24. The process for stabilizing a lignocellulosic material according to any one of claims 19 to 23, wherein the heating of said lignocellulosic material is effected by high-frequency heating in the course of the passage of the lignocellulosic material through said opposed zone between the pair of endless belts.

25. The process for stabilizing a lignocellulosic material according to any one of claims 18 to 24, wherein said lignocellulosic material is maintained at a high temperature of about 150°C to about 250°C and then at a low temperature of 100°C or lower, preferably 80°C or lower during the passage of the lignocellulosic material through said opposed zone between the pair of endless belts.

26. A device for stabilizing a lignocellulosic material comprising:
a pair of endless belts adapted to have at least ion part an opposed zone and to be such that the opposed surfaces travel in the same direction;
a means for feeding a lignocellulosic material to said endless belts; and
a means for heating the lignocellulosic material fed, said means being located in said opposed zone between the pair of endless belts.

27. The device for stabilizing a lignocellulosic material according to claim 26, further comprising a means for preliminarily compressing and preliminarily heating the lignocellulosic material fed, said means being upstream relative to said opposed zone between the pair of endless belts.

28. The device for stabilizing a lignocellulosic material according to claim 26 or 27, further comprising a steam supplying means for supplying high-pressure steam toward the lignocellulosic material in said opposed zone between the pair of endless belts.

FIG.1

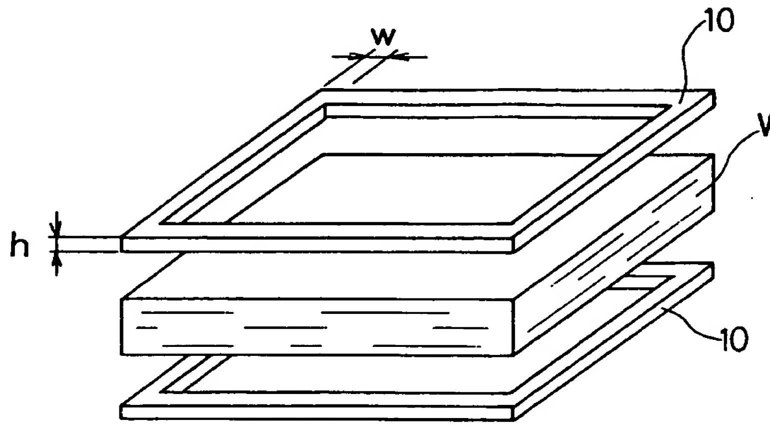
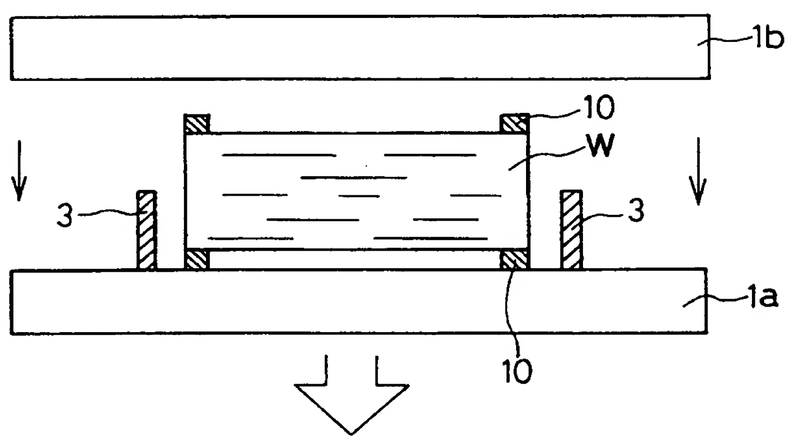


FIG.2

(A)



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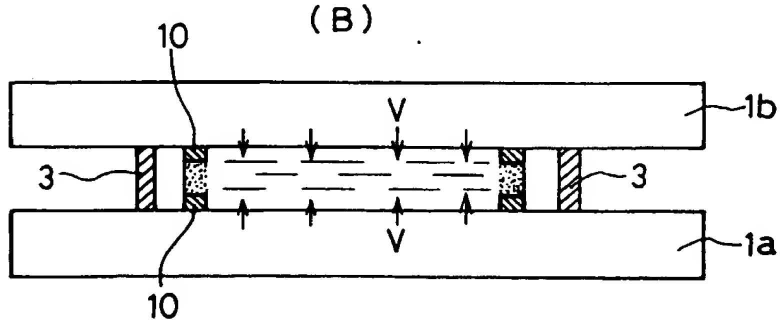


FIG. 3

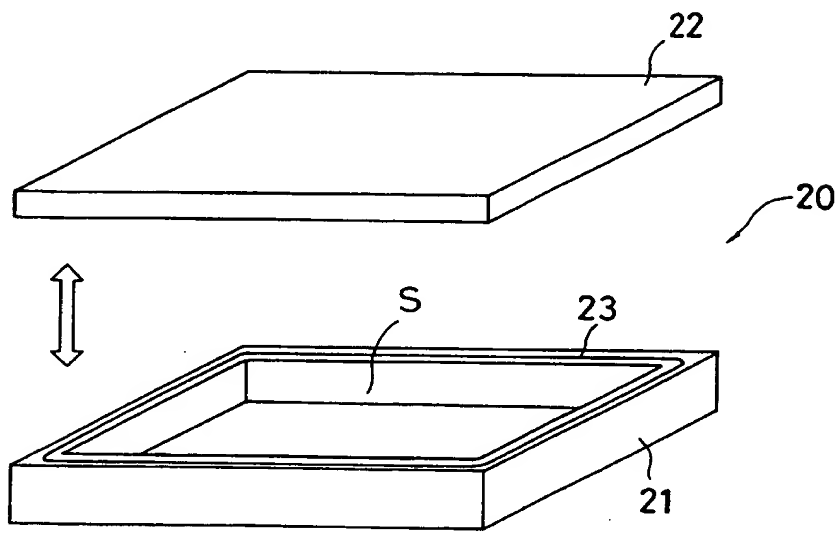


FIG. 4

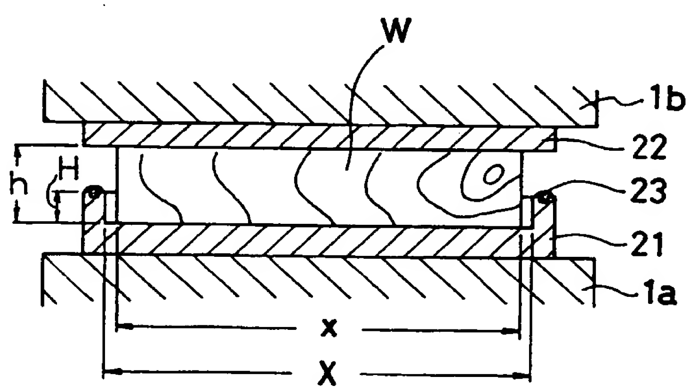


FIG. 5

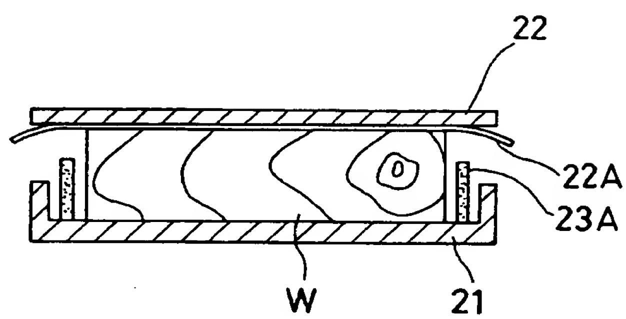


FIG. 6

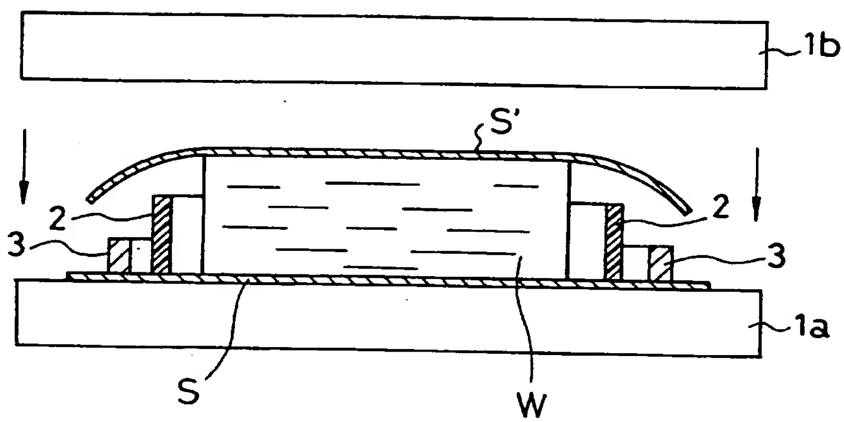


FIG. 7

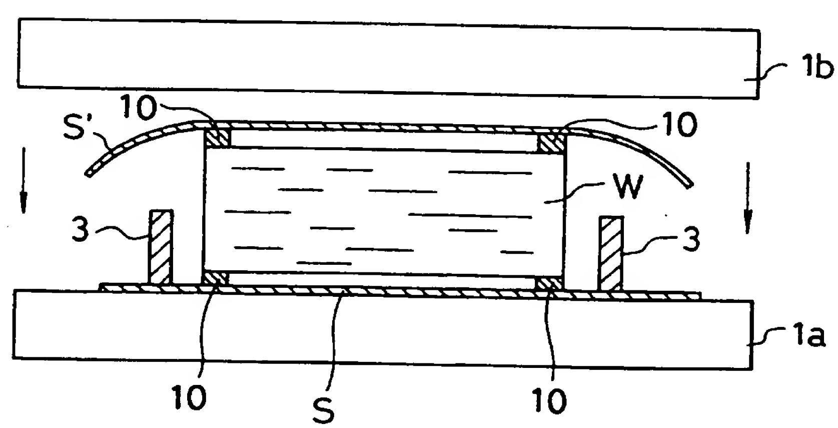


FIG. 8

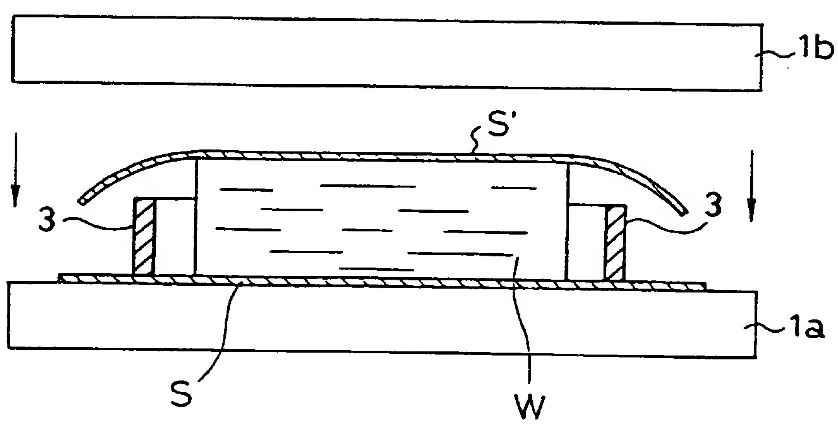


FIG. 9

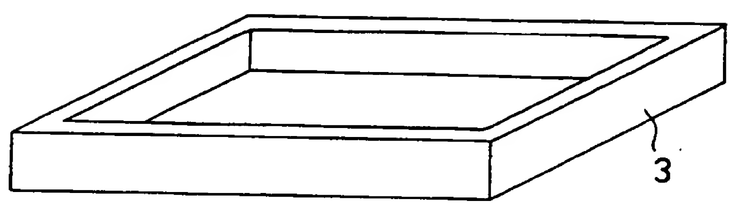
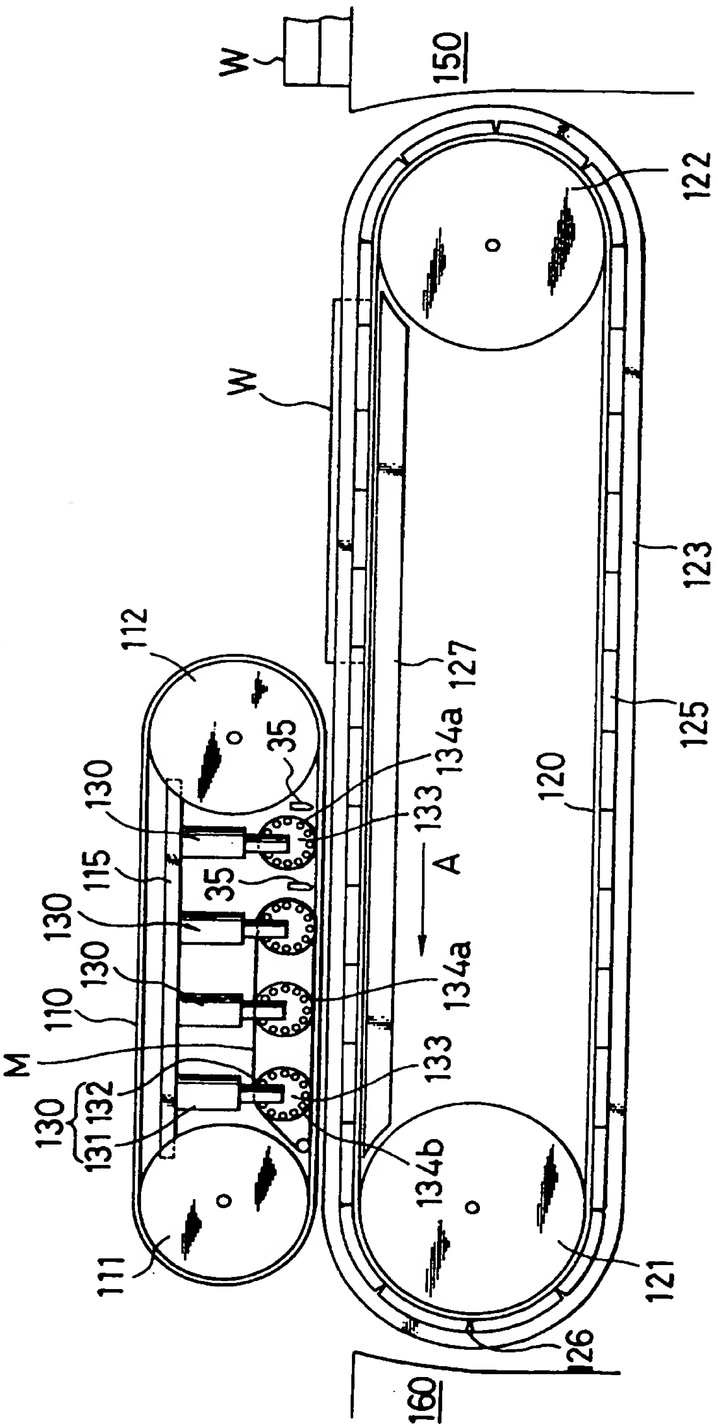


FIG.10


W
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134a
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126
160

FIG.11

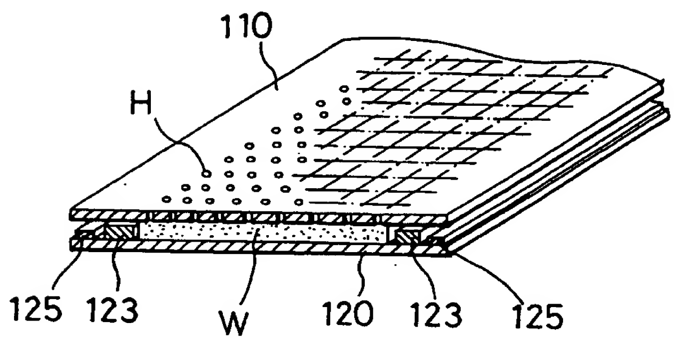


FIG.12

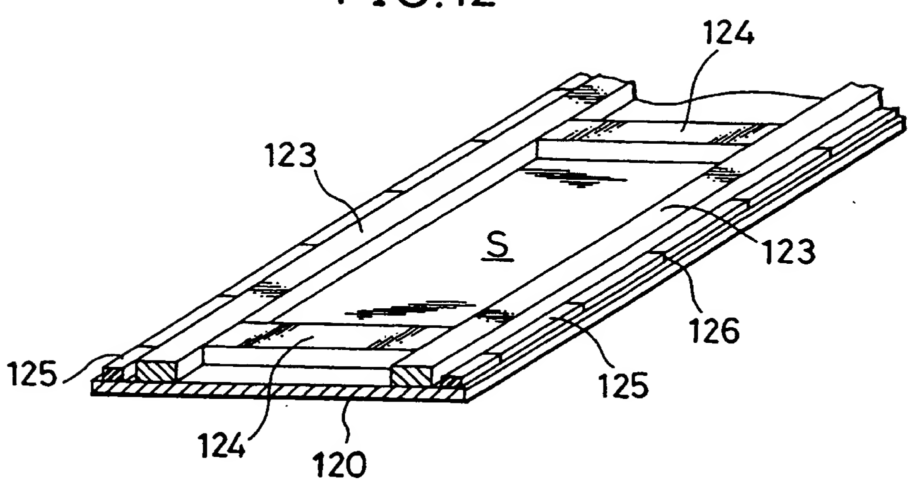


FIG.13

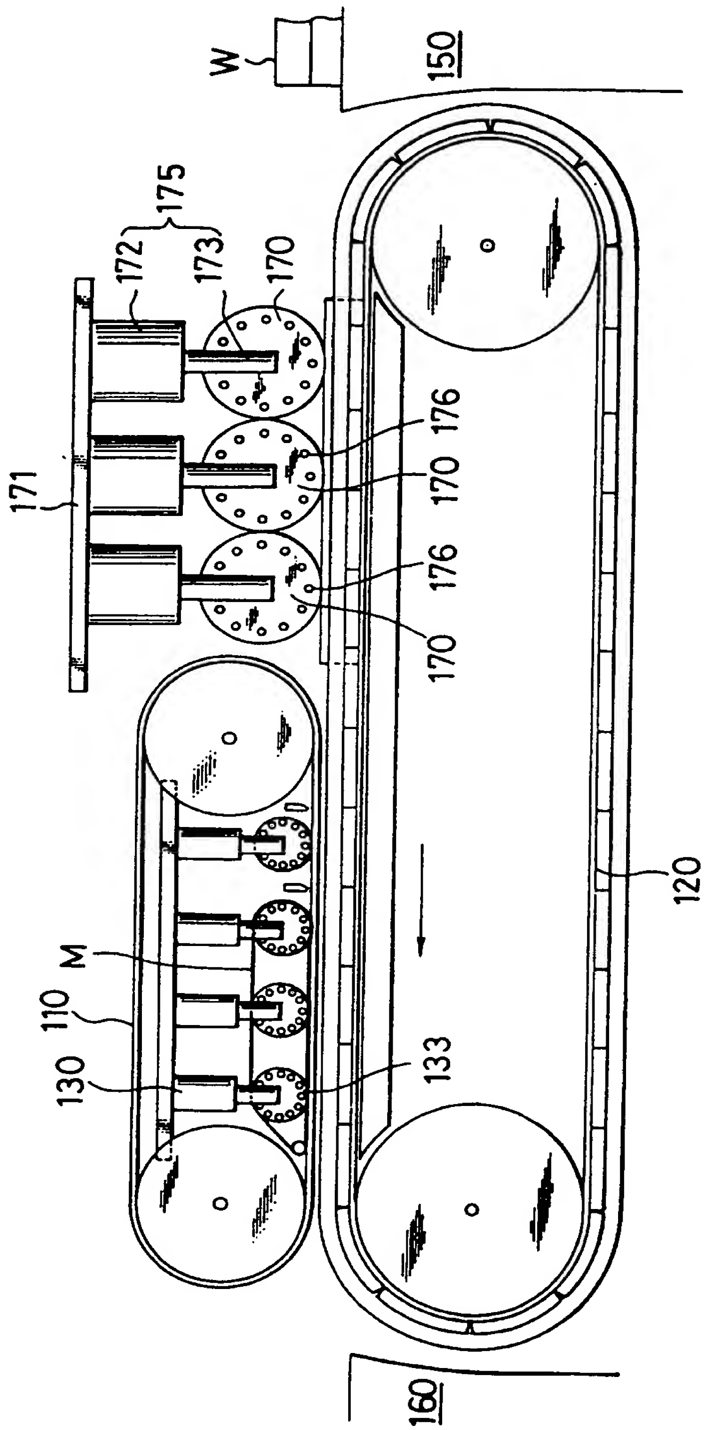
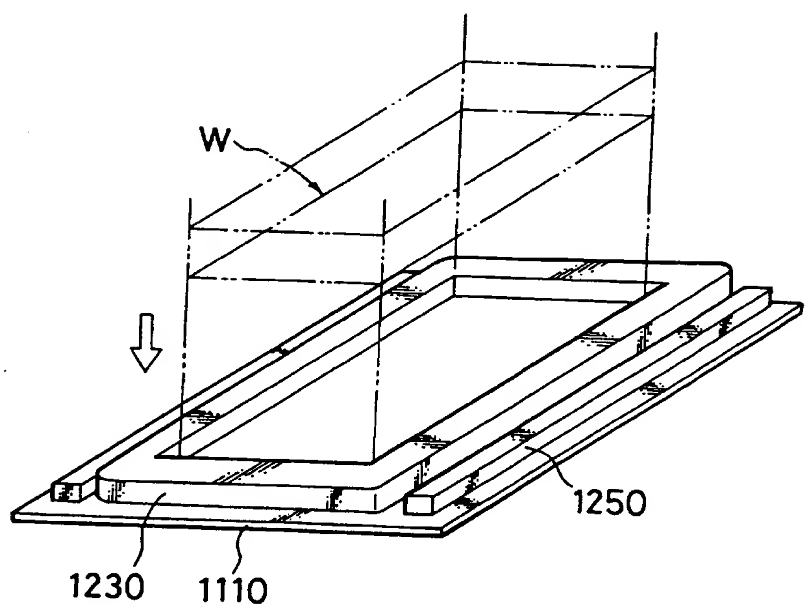


FIG.14



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 1140

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	FR-A-2 023 547 (INSINOORITOIMISTO ALPO MAKINEN & CO) * page 1, line 1 - line 33 * * page 2, line 11 - line 13 * * page 3, line 16 - line 18 * * page 4, line 1 - line 30; figure *	1-10,13, 15	B27N3/24 B27N3/20 B27N3/08
Y		22-25	
A	---	11,16	
X	DE-A-40 09 883 (G. SIEMPELKAMP GMBH & CO) * abstract; claims; figure 1 *	26-28	
Y	---	22,23,25	
X	DE-A-27 22 356 (BISON-WERKE BÄHRE UND GRETEN GMBH & CO) * claims; figure *	26,27	
Y	---	22,24,25	
X	EP-A-0 383 572 (CSR LTD.) * abstract; figures 1,2 * ---	26-28	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
A	DE-A-38 34 263 (TH. GOLDSCHMIDT AG) * abstract * ---	12,13,18	B27N B28B
A	US-A-1 349 318 (W. W. CAMP) * claims 22-25; figure 6 * ---	19-21	
A	EP-A-0 411 598 (LOSIO, GIANFRANCO) * abstract; figure 2 * ---	11	
A	FR-A-2 175 170 (BISON-WERKE BÄHRE & GRETEN GMBH & CO) ---		
A	US-A-4 111 744 (REINIGER) -----		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 April 1994	Soederberg, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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P : intermediate document

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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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